The Journal of Industrial and Engineering Chemistry

Published by THE AMERICAN CHEMICAL SOCIETY

AT EASTON, PA.

Volume VII | APRIL, 1915 | No. 4

Published monthly. Subscription price to non-members of the American Chemical Society, $6.00 yearly.
Foreign postage, seventy-five cents, Canada, Cuba and Mexico excepted.
Entered as Second-class Matter December 19, 1908, at the Post-Office at Easton, Pa., under the Act of March 3, 1879.

Contributions should be addressed to M. C. Whitaker, Columbia University, New York City
Communications concerning advertisements should be sent to The American Chemical Society, 42 West 39th St., New York City
Subscriptions and claims for lost copies should be referred to Charles L. Parsons, Box 505, Washington, D. C.

Eschenbach Printing Company, Easton, Pa.

TABLE OF CONTENTS

EDITORIALS

ANOTHER GREAT DISCOVERY

A discovery of enormous potential importance to the chemical profession has been made within the last few months by the general public. Hundreds of newspapers and periodicals are devoting editorial space to the discussion of the chemists and chemical engineers and their relations, and especially their obligations, to the coal-tar dye industries. The public acknowledgment of our responsible connection with this important industry is a great accomplishment for our profession when we recall that only six months ago the chemist was known chiefly by the drug store he kept. Every worker thrives upon public recognition of his achievements. The chemist is no exception to this rule, yet from the obscure and involved nature of his work and his natural secretive instincts he has received less public acknowledgment than the workers of any other profession. It matters little whether the chemical profession comes into view riding the spectacular coal-tar dye hobby, whether it is "trimmed" by the public press for its lack of initiative in seizing opportunities, or whether it is charged with an utter absence of business acumen, so long as it comes to be publicly recognized as an important and an essential factor in the industrial development and councils of this country.

If the newspapers make mistakes in discussing our intricate scientific and industrial problems, we should not be content to blink and chuckle in our superior wisdom, but should come out in the open and set them right. If legislative styles point unmistakably to pension log-rolling, bureaucratic log-rolling, tariff log-rolling, it is our duty to teach legislators the value of rolling the logs that will develop the industries which support our profession.

The public have been left to their own resources to figure out the function of the chemical profession. We publish one thousand copies of our Journals each day in the year, but they are for the chemists, and are free from matters of public interest. The directory of our Society—the largest technical society in the world—gives no hint of the vast and varied field of professional activity of the chemist. Our public work is obscured by impenetrable technical detail and our industrial achievements are cut off from public view by high factory walls. Public sources of information as to the field of activity of the chemist are thus limited to the signs displayed on the corner drug stores. We have labored for years under cover. Is it any wonder, then, that we were still undiscovered when the foreign crisis disclosed to the public the fact that some of our great industries depended for their development and continuance upon the work of the chemist? Nevertheless, there are many other fields of activity besides those which have recently become of interest to the public, in which the chemist and the chemical engineer have contributed much to industrial wealth.

The time seems ripe for coming out in the open and showing the public in clear and authoritative form the place of the chemist in industry. We publish in THIS ISSUE a series of papers written by eminent specialists—chemists, chemical engineers, administrative officials and industrial managers—who see and present from various angles the contributions of the chemical profession to our industrial development. These papers cover but a few of the industries benefited by the science of chemistry. We hope to publish many others of the same kind and thus bring to light a better understanding of the world's work of the industrial chemist and the chemical engineer.

ON SYNTHETIC DYESTUFFS AND OUR EXPLOSIVES

Under the title of "The Dyestuff Situation and Its Lesson," we printed in the March number of This Journal an address by our ex-president, Arthur D. Little. Were it not for the prominent position occupied by him, in view of the many reports and papers written, we would make no comment, as the subject has become threadbare. From a standpoint of patriotism, however, if for no other reason, we challenge his conclusions. While he is stopping the "wasting precious ammonia" the no less precious benzol, toluol, carbolic acid, etc., are to go to waste, or be exported to be returned to us as finished products.

It is admitted that we can have a dyestuff industry in this country if it is protected with an *ad valorem* duty of 30 per cent, plus a specific duty of $7^1/_2$ cents per pound. Let us see what this means to the mind of the man or woman who is called upon to pay the tax. Dr. Hesse tells us: that the cost of the dyestuff, including this duty, would not be over 15 cents per annum per capita of our population; that the dyestuff entering into a suit of clothes costing $25.00 would not buy a good cigar, and, including the proposed duty, would be less than 5 cents per suit.

He asks why then "should we duplicate them (*i. e.*, German Color Works) only to plunge into an industrial warfare against the most strongly fortified industrial position in the world." In answer, let us quote from what Dr. Schweitzer says in an article on German militarism.

"The industry for the recovery of the by-products from the coking process, which we already mentioned as a source for sulfate of ammonium, has also been highly developed because German militarism needed some of the resulting coal-tar products for the manufacture of explosives. Benzol, toluol, carbolic acid, metacresol and diphenylamine are starting materials used in the manufacture of ammunition."

Bearing this in mind let us see what Dr. Hesse says on the subject in a report which was read into the records of the House of Representatives, dated December 10, 1914, by Hon. Samuel Wallin:

"The best information your committee has so far been able to gather is that this country can produce so-called coal-tar raw material in amounts sufficient for the needs of a complete domestic coal-tar chemical industry, inclusive of explosives and dyes, provided there is a certainty of outlet as to volume and continuity.

"There is no inherent defect in our coke industry with regard to the actual making of these things; the only question involved is whether it be more profitable to burn the benzol, toluol, and the like, contained in the gas, as a fuel, than to separate them from each other for purposes of sale.

"The materials of the preceding paragraph are the ones used in the coal-tar explosive industry, as well as in the coal-tar medicinals and dyestuffs industries. Each of these three industries coöperates with the others to make full use of those materials; alone none can fully make use thereof nor succeed; the correct and proper utilization of these materials require successful coexistence of all three industries in one and the same country."

In a statement made by H. A. Metz, before the Committee of Finance of the U. S. Senate, 62nd Congress, on the matter of duty on Aniline Oil and Salts, he said: "or if the foreigners did not drop their prices the articles would probably be made here, and provide the basis for a real coal-tar (chemical) industry, etc."

Here we find the motive for the opposition by the foreign manufacturer and their agents, because if the dyestuffs industry was assisted by proper protection in this country they know that in ten years we would compete with them in the markets of the world.

T. B. Wagner has given us a text on the subject when he stated in his address before the American Institute of Chemical Engineers that:

"Strange as it may seem, the starting of industrial enterprises is not always due to the chase of the almighty dollar, as is generally and perhaps pardonably assumed, but in many instances it is directly caused by the enactment of laws with more or less restrictive tendencies."

Switzerland produces neither coal, coke nor coal tar, and yet of the 16.6 per cent of dyestuffs not obtained from Germany in the year 1913 by this country the major part was obtained from Switzerland. Switzerland then could hold us at her mercy because of her ability to supply herself, or other nations who might be at war with us, with explosives. We can read between the lines.

There is no secret whence the success of the foreign coal-tar chemical industry. It is fully set forth in the report of the U. S. Tariff Board dated February 7, 1912, pages 225 and 226:

"The German chemical industry knows practically no competition between individual establishments engaged in the manufacture of the same products; and the elimination of competition and general tendency toward combination observable in all industrial countries, but especially pronounced in Germany, has in that country gone further in the chemical and allied industries than in any other manufacture. This has been accomplished by the formation of 'syndicates,' 'cartels,' 'selling associations,' and to a lesser degree by the absorption of, or amalgamation with, rival concerns, formed secretly or openly for the purpose of controlling output and prices. The law puts no obstacle in the way of such consolidation, and in several instances governmental agencies operating large chemical establishments form a party to the agreements. * * * * Practically all the important manufactures of the chemical industries and many products of lesser importance are under some form of syndicate control, more or less strict, and more or less extensive as to production, prices, supply of raw materials or division of territory. Chemical manufactures lend themselves more readily to consolidation than any other, because within a given line the products from one source are not visibly different from those of other sources, and, on the same basis of purity, do not differ at all. The products, therefore, carry little if any individuality, which is the principal basis of competition. Quite a number of these organizations are bound by agreements of some kind to international 'cartels,' the object of which is to control the international markets."

Should the American manufacturers use similar methods, indictments would promptly follow. Were they permitted to use them, however, the foreigner would unquestionably be beaten at his own game. If then it is not the desire of the people of this country to foster its aniline industry, let us, at least, as a matter of patriotism, demand that our Government enter into the manufacture of the necessary explosives derived from the coal-tar chemical compounds, although in so doing our ammunition of the character described by Dr. Schweitzer and quoted above will cost the country many, many times what it could be supplied for by an established and protected aniline industry in the United States. T. J. Parker

SYMPOSIUM ON THE CONTRIBUTIONS OF THE CHEMIST TO AMERICAN INDUSTRIES

Papers presented at the 50th Meeting of the AMERICAN CHEMICAL SOCIETY, New Orleans, March 31 to April 3, 1915

CONTRIBUTIONS OF THE CHEMIST TO THE WINE INDUSTRY

By Charles S. Ash

Demonstrating the value of chemistry and chemists to an old established industry, which has been commercially successful without either, is never an easy matter. To attempt such a demonstration to the wine industry of California fifteen years ago seemed like an almost hopeless as well as an entirely thankless task.

The California wine industry had been established by European wine makers some thirty years before and for that length of time had been conducted by "thumb and screw" rules. While wines of good quality were not turned out each year, the results obtained by the wine maker were entirely satisfactory to the dealer. Spoilt and poor wine was attributed to a "poor vintage."

The arguments which could be advanced at that time showing the value of the chemist to other industries had little effect. When the chemist looked for employment in the wine industry he was naturally asked what he could do for the benefit of the industry. On replying that he could make an analysis of the wine, he was met with this answer—"Well, after I know the composition of the wine what good does it do me? Can you tell me whether the wine is good, bad or indifferent? An expert taster can tell all these things." Of course, a chemist knowing nothing about wine could not interpret the analysis he had made, and an analysis without an interpretation is useless, while an incorrect interpretation is fatal. So the stand taken by the wine merchant was absolutely correct, as far as his knowledge went. The fallacy of his position at that time (15 to 20 years ago) was that he unknowingly did depend upon the chemist. Chemical preservatives were in common use all over the world, their preservative value having been discovered by chemists. All wine having a sufficient quantity of preservative was sterile and, therefore, gave no trouble after shipment.

The chemist begins to be of value to the wine industry only when he becomes familiar with the wine business and becomes a wine man. When that happens he will know that as wine is a natural and not a synthetic product, he must adjust his scientific knowledge to the nature of the product and not try to change the character of wine to meet his scientific views. As the chemist becomes familiar with the wine he will be able to interpret his analyses correctly, to segregate the sound from the unsound wines and to anticipate their stability. This was most desirable and useful to the wine merchant. Pure food laws were coming into effect in European countries. Salicylic acid (the preservative commonly used) had to be abandoned and the chemist was instructed to look for a preservative that could not be detected. At that time benzoates were very difficult of detection and benzoic acid was adopted as a preservative. But analytical science soon caught up, and benzoates also were of no value. The chemist is still looking vainly for a preservative that cannot be detected.

As wine makes itself spontaneously when the grapes are crushed, it was considered a purely natural product and its goodness or badness the result of chance. So we have to this day the much-abused phrase, "the fine vintage of 188–." The reasons for good and bad vintages were unknown. To be sure, Pasteur had made his classic researches and his views had slowly made themselves felt throughout the world. Where pure yeast was planted in sterile media, as in beer, the quality of the resulting product was largely dependent upon the quality of the yeast. In the manufacture of wine, it is obvious that the must cannot be sterilized in the same way that beer can be. The chemist at this time, being able to anticipate the stability of a natural wine, concentrated his effort upon the production of wines of sufficient stability to keep in a warm climate rather than the finding of a preservative that could not be detected. The use of a preservative in such a wine would only add to the cost and do little, if any, benefit. It holds good in all food industries, I think, that the need for preservatives decreases as knowledge of the product increases. Through the efforts of the writer, wine was shipped without preservatives as an experiment: the first car was shipped with many misgivings. It was expected that every barrel would blow up, and the entire carload be lost. This was a very trying time for the chemist, as his theories were on trial and a failure meant a return to the old régime. The car, however, gave perfect satisfaction and nothing was heard afterwards. From that time on, the use of preservatives decreased and methods for improving the vintage increased; in fact, a chemist's knowledge took the place of preservatives in the business.

The production of stable wine—that is, a wine that does not deteriorate on shipment—is a most complex problem. To go into the problem is outside the province of this short paper. It can be said, however, that if the chemist has been of any benefit to the wine industry he has been of benefit here. To the direct question—"What has the chemist done for the wine industry?"—one can with justice reply:

1—By proper methods of handling he has made the use of preservatives unnecessary.

2—He has insured the uniformity of the product as completely as seasonal differences will allow.

3—He has reduced the quantity of spoilt wine from 25 per cent to less than 1 per cent (about 0.46 per cent average).

4—He has reduced the quantity of inferior wine from 25 per cent to 5 per cent. (Some grapes always give inferior wine no matter what care is given to the products. Usually these grapes are those grown on over-irrigated ground and over produce.)

One of the most important duties of the chemist is, as we have said, the production of a uniform product, without which uniformity no business can be successful. Some details may not be out of place. There is no difficulty in turning out, for example, a uniform sugar, but a uniform wine is less easy. Every vintage is slightly different, yet if a brand of wine be established it is necessary to supply your customer always with wine of exactly the same type. Otherwise, the consumer, being used to the one wine, objects to the other. The wine chemist has to help in the attaining of uniformity. As the blending of wines is the final operation, and as these blends compose at times 100 different wines, this is perhaps one of the most important duties of the wine chemist. Blends are usually made up first in sample, analyzed, blended as nearly as possible to the composition of the previous blend of this type, and the directions for the blends then distributed to the winery which is to make them up. After blending, samples are again sent to the laboratory where the chemist again analyzes them to see whether the blends have been properly and uniformly made.

The following samples show the method of checking the blending. The analyses of the sample blend made in the laboratory, and the actual blend made in the cellar must agree; otherwise, the blend is not uniform and must be reblended.

	Per cent alcohol by volume	Grams per 100 cubic centimeters: Total acidity	Volatile acidity	Reducing sugar	Tannin
Winehaven Claret—Blend No. 485 (265,000 gallons)					
Sample blend	12.29	0.500	0.060	0.145	0.135
Finished blend	12.37	0.510	0.060	0.150	0.140
Wahtoke Port—Blend No. 482 (144,500 gallons)					
Sample blend	20.78	0.390	0.043	6.60	0.070
Finished blend	20.78	0.390	0.046	6.63	0.079

Besides this, the wine chemist has duties in common with all chemists. He must analyze the water and soils of the vineyards owned by his company, analyze the supplies used in the wineries or in the vineyards, advise as to fertilizers to be used and devise means to gather as many by-products as possible.

I must say, in conclusion, that the wine chemist, in spite of temporary discouragements, is having more intimate relations with the Wine Industry. He is, in fact, becoming quite friendly, and he has hopes of being on the same good terms as his brothers in the sugar, dyeing, oil, petroleum, gas, soap and other industries, which the chemist has made famous.

MONADNOCK BUILDING, SAN FRANCISCO

CONTRIBUTIONS OF THE CHEMIST TO THE COPPER INDUSTRY

By J. B. F. HERRESHOFF

Vice-President Nichols Copper Company and Consulting Engineer General Chemical Company

During the last forty years there has been an enormous increase in the copper mined, smelted and refined in the United States. The following figures clearly show this increase:

In 1874 the United States produced	17,500 long tons
1884	64,708 long tons
1894	158,120 long tons
1904	362,739 long tons
1912	563,700 long tons

Of the 17,500 tons produced in 1874, Calumet & Hecla produced 87 per cent. This was before the producing days of Montana and Arizona copper, which began in about 1883.

It is fair to assume that there were very few, if any, chemists employed in the copper industry in the United States in 1874. At that time, among the few laboratories in New York City, the largest one made only one or two copper analyses per year, and it was known then that Calumet & Hecla had employed one of the very few expert chemists in the country to help them, if possible, out of some chemical difficulty.

About 1884 a few chemists were employed in the earlier work of developing going on in Montana and Arizona. You will notice the marked increase in the output of copper from the years 1884 to 1894. It was not until after 1890 that the real value of chemists in improving operations in mining, as well as in concentrating, roasting, smelting and refining copper was fully appreciated. From that time to the present the value of chemists in the mining and metallurgical work in the production of copper has very greatly increased, and the number of chemists employed is greater in proportion than the enormous increase in copper produced.

In the large copper mines of this country chemical analyses are made and used to very great advantage in the control of mining operations and also in connection with sorting the ore before crushing. Ores from different parts of a mine have varying percentages of copper and differ often to a great extent in their fluxing properties, so that a bedding system is sometimes employed, placing the various grades of ore in different beds of bins. All of this ore has to be analyzed and then careful chemical calculations are made by the metallurgists, so that the proper proportion from each bin is mixed when delivered in the smelter.

In the concentration of ores the process is, to a considerable extent, a mechanical one, although of late electricity for separation and concentration is employed, and also a process that uses a moderate amount of oil which facilitates a more perfect separation of the mineral from the gangue. Whichever method is employed, a control by chemical analysis is necessary to show the gains or losses in copper.

In the successful smelting operations at many of our large mines the metallurgist who calculates the best smelting mixture of ores and fluxes to be introduced into the smelter, has to be not only an able chemist, but should be a physicist and engineer as well, in order to obtain the most economical results. To carry out this important work a great many chemical analyses are necessary, for the best results in roasting ores in the modern roasters can be produced only by the full employment of chemical analyses and physical tests.

The United States mines more than 50 per cent of the copper of the world; 75 per cent of the copper of the world is refined in this country and the larger proportion of this refining is done by electrolysis. In carrying on this electrolytic work the chemist has been responsible for a very large proportion of the improvements that have been made in the last twenty years, so that chemistry has shown itself to great advantage not only in improving the electrolytic methods of refining, but also in the preceding methods of mining and smelting.

In the electrolytic refining of copper, samples representing 80 to 100 tons of blister copper are analyzed for copper, gold and silver in order to arrive at the value of the lot. Formerly the analyses of copper were not exact enough to satisfy the buyers and sellers. The chemists then came together and improved the methods so much that perfect satisfaction now exists. It is not unusual in a copper works laboratory to have two chemists make independent analyses of the same sample and turn in results, which agree to within 0.01 per cent on blister copper and 0.002 per cent on refined copper.

More than one-half of the copper refined is cast into wire bars and then rolled and drawn into wire, the bulk of which is used for electric conduction. A very small quantity of arsenic in copper greatly lowers its conductivity; a quarter of one per cent cuts down its electric conductivity from 101 to 45. Refined copper for this purpose should contain less than one-thousandth of one per cent arsenic in order to satisfy the consumer. The chemists have made such results possible by their able research work and also by their remarkable improvements in analytical methods for copper and arsenic and their wonderfully exact methods for determining quantitatively minute quantities of bismuth, antimony, tellurium and selenium in copper.

These results could not have been obtained twenty years ago, and forty years ago even the best chemist in the country could not have dreamed of doing such work. In the great improvements in the copper industry our chemists have performed a very important part in a very able manner. The great consumers of copper in large manufacturing industries of this and other countries, and the whole world, owe to the chemists connected with our copper industries a debt of thanks for their masterly work.

25 Broad Street, New York

CONTRIBUTIONS OF THE CHEMIST TO THE CORN PRODUCTS INDUSTRY

By E. T. Bedford

President Corn Products Refining Company

The industry of glucose and grape sugar, or, as it is known in this country, the industry of corn products, is based upon an epoch-making discovery of a chemist—the conversion by chemical means of starch into reducing sugars. The chemist has been inseparably connected with this industry from its beginning. It was started in Germany a little over one hundred years ago, and due to the limitation of the products—there being only two, glucose and grape sugar—the field and the activities of the chemist were limited correspondingly, but conditions in this country afforded him much larger opportunities, and I am glad to be able to say that the American chemist did not overlook his opportunity, but was quick to make the most of it. Owing to the character of the raw material employed in this country—corn—our products are no longer limited to two; the chemist has added to them until their number now exceeds one hundred. We produce a large number of different grades of glucose, or corn syrup, suitable for every conceivable purpose, either as food or in the arts. Manifold as the technical uses are, they are overshadowed by the great value of glucose as a food. This fact is emphasized in these days of high-priced food. Its importance and significance as an ideal food for the masses was pointed out very forcibly by Prof. Graham Lusk, who showed conclusively that glucose is the cheapest food-fuel known. Grape sugar, or corn sugar, also is an important product, and is manufactured in a variety of grades. Due to the great care which the chemist exercises in devising ways and means of controlling the process of manufacture in all of its details, the quality of the articles produced is of such excellence as to have secured for this country by far the largest portion of the world's trade in these commodities.

While the chemist was most active from the very beginning in developing the process for making glucose and grape sugar and in steadily improving their quality, he also demonstrated his value to the industry by developing new staple products such as starches for culinary and technical purposes, of dextrins and gums and various sugars, which in point of purity rival cane and beet sugar. These products are now manufactured in this country in very large quantities and are being shipped to all parts of the world. A brief reference to statistics will illustrate the effect of such work. The corn manufactured into corn products in this country amounts to 50,000,000 bushels per year. It is converted into 800,000,000 pounds of corn syrup, 600,000,000 pounds of starch, 230,000,000 pounds of corn sugar, 625,000,000 pounds of gluten feed, 75,000,000 pounds of oil and 90,000,000 pounds of oil cake.

The chemist soon recognized the large possibilities which lay in the utilization of certain constituents of the raw material which were allowed to run to waste. First among these were the nitrogenous substances, commonly classified under the name of "gluten." Their running to waste was stopped; the product was collected, washed and dried, and put upon the market as a cattle feed of great nutritive value; it has materially increased the revenue obtainable from corn. I should like to say in this connection that I hope the chemist will again concentrate his attention upon this product and within a reasonable time convert it into an article of food to be used by man rather than by animals.

The recovery of the outer hull of the corn, the bran, followed next, and by applying practically the same methods it was obtained in a dry state and soon became an article of commercial importance.

With the recovery of these products, the impetus was given to a further exploitation of the other ingredients of the corn, particularly its germ, which contains a large amount of the article, commercially so important, and known as "corn oil." The chemist observed that, due to its lighter specific gravity, the germ could be separated from the body of the crushed corn by a very simple method, and so sound was the reasoning of the chemist leading to an almost mathematical separation of the germ, that the same principle is today still employed, although the invention itself was made over 30 years ago.

The chemist next turned his attention to the soluble solids lost in the water which is used in the softening or steeping of the corn, which water formed an ordinary trade waste. These solids consist of nitrogenous matter, sugars and other carbohydrates, the valuable organic phosphorus compounds and the salts of magnesia and potash.

There are numerous other products which the chemist evolved; among them glycerine and fatty acids from the oil, soap stock from other oil-containing by-products, innumerable special starches for specific purposes, and dextrins and gums of great variety.

These developments have made the products of corn the equals of competing products obtained from wheat, potatoes, sago, rice and other amylaceous sources; and where the products from corn were looked upon at one time as substitutes for the more expensive starch products obtained from other sources, they are sold today upon their own merits, which are recognized and appreciated very keenly by the trade. It goes without saying that the development of our industry would not have made such rapid strides if it had not been for the excellent work of a highly efficient sales organization and for the coöperation of the engineering forces; nevertheless, the effects of the activity of the chemist are noticeable in every direction, and it is not an exaggeration to say that the great American industry of corn products owes its existence primarily to the chemist; while it may be admitted that further expansion of the business will be largely in the direction of commercial development, I am firm in my conviction that the chemist will continue making his influence felt in our industry, that the future holds in store a great evolution of the industry and that to this evolution the chemist will contribute, as in the past, a substantial share.

17 Battery Place, New York

CONTRIBUTIONS OF THE CHEMIST TO THE ASPHALT INDUSTRY

By James Lewis Rake
Secretary The Barber Asphalt Paving Company

Chemistry, in the service of the asphalt industry, has converted it from one which originated on purely empirical lines into one which is now founded on a rational and highly scientific basis. The development and perfection of the industry from a technical point of view has been made possible only with the aid of chemistry, intelligently associated with practical experience and service tests. During the first two decades of its existence it was conducted on no fixed principle. The hard, refined Trinidad Lake asphalt was fluxed with a heavy petroleum oil, not manufactured especially for the purpose, to form an asphalt cement of a consistency determined solely by personal judgment. This was mixed with hot sand of varying degrees of fineness and with a certain amount of powdered limestone in purely haphazard proportions which were not rationally determined. These mixtures were laid and compressed in the street with most uncertain results, sometimes excellent and sometimes very bad. When the irregularity of such work was recognized, an appeal was made to the chemist, who selected typical samples of these old pavements and resolved them into their constituents by analytical methods. It was found that surfaces which gave good and those that gave poor service were of very different and distinctive characters and that the manner in which they behaved depended upon the original properties of the mineral matter, sand, and powdered stone, as well as the consistency of the asphalt cement used. The chemist devised means of controlling the consistency and regulating the size of the sand by means of sieves, evolving a rational method of construction, which has been followed for twenty years, making the industry, when carried out on such lines, an extremely reliable one, and all work, if controlled by definite tests and analyses, of highly satisfactory character.

The chemist has also given his assistance in the preparation of fluxes or heavy oils of suitable character, and in the fixing of a standard for the grading of the sand and the nature and amount of filler or powdered stone, which enter into an asphalt pavement.

Aside from this, he has studied the nature of the native bitumens which are the components of asphalt and has differentiated the various types which are found in nature. In fixing the characteristics of the asphalts and the various petroleums from which fluxes and residual pitches are obtained, he has made it possible to describe these materials with such accuracy in specifications that they are readily differentiated.

He has made a study of the behavior of asphalt surfaces under service tests, and has been enabled to draw valuable conclusions therefrom which are applicable to the improvement and development of the industry. He has studied the physical characteristics of the sand used and of the phenomena connected with its behavior in combination with fine powders. He has demonstrated the fact that the presence of large amounts of this fine powder and filler through the presentation of a very large surface for the adhesion of the bitumen, adds in an enormous degree to the success of an asphalt surface under heavy traffic, in which study the principles of physical chemistry are closely involved. Work along these lines is still being undertaken in the laboratory, and it would seem that equally interesting points are to be developed in the future as in the past, along the lines of chemistry and physics.

Results obtained in these directions have been on such a large scale that the data accumulated have been assembled in a book of more than 600 pages by an expert of the company with which the writer is connected.

Land Title Building, Philadelphia

CONTRIBUTIONS OF THE CHEMIST TO THE COTTONSEED OIL INDUSTRY

By David Wesson
Manager of the Technical Department, Southern Cotton Oil Company

In 1834, an English traveler in this country, writing about cotton culture, said: "In many places it is usual to manure the fields with the seed not used for sowing; but of late years experience has taught the planters to set a higher value on it as it contains a considerable quantity of oil which is extracted by pressure and is suitable both for burning and painting. This oil may, in the course of years, become an additional source of wealth to the planters."

About twenty years afterwards—shortly prior to our Civil War—one or two mills were started in New Orleans. The industry, interrupted by the war, acquired a start shortly afterward, and in 1872 as much as 52,705 tons of seed were crushed. This amounted to 4 per cent of the entire crop of 1,317,637 tons. In 1913, with a production of 6,305,000 tons, 4,767,800 tons were crushed, or 75.6 per cent of the entire crop. The estimated average cost per ton was $25.35, and the total value of the seed alone was $120,840,000, while the value of the products was $156,600,000. Needless to say that the oil was used for something besides burning and paint.

The first refineries in this country were the Aldige, Union and

Maginnis in New Orleans, Union in Providence, and J. V. Lewis in Cincinnati. Most of the early product was used for adulterating olive oil, except when it was labeled and sold as that material.

In 1887, the writer had the privilege of visiting these refineries, which were probably operating then very much as they had been doing for years. The crude oil was refined with caustic soda, and the strength of lye was largely a matter of taste on the part of the refiner. The quantity used was left entirely to his discretion. The crude oil was judged by taste, color and smell, and caustic added till the required color was obtained on a filtered sample. There were as many styles of kettles and agitators as there were refineries. Most of the refiners were practical men, and they were chock-full of theories. One of these practical refiners mixed his lye in round-bottomed sugar cauldrons, and another judged the strength by rubbing a few drops between his thumb and fingers.

The crude oil mills were run very much like the refineries. The export trade liked soft, yellow cake, so some of the mills, trying to make what was wanted, would leave from 12 to 16 per cent of oil in the cake and meal. They also allowed large quantities of meats to go into the hulls, and annually sacrificed large amounts of perfectly good meal and oil in the form of settlings, which were allowed to ferment and were originally put in the soap kettles.

It was about this time that chemistry began to take the industry in hand. Crude oil, up to now, had been bought and sold as prime, or prime for the season, or off, and was passed upon by manufacturers and brokers, who looked at it, tasted it, then looked wise and gave their verdict. Then the chemist stepped in and found that the quality of the oil closely followed the free acid present, and started grading accordingly. This made a big stir. Some of the mill owners denied the possibility of free fatty acid being present in any of their oil, as they never had any fatty acids on their premises. The chemists then showed these same mill men how much oil they were losing in their cake and throwing away in their hulls, with the result that more oil was made per ton of seed.

The hulls were burned under the boilers and furnished the power for the mills. Every ton of seed furnished about 700 lbs. of hulls. The ashes, averaging about 10 lbs. per ton of seed were a valuable by-product, being rich in potash and phosphoric acid. The writer is in doubt whether it was a chemist or a cow that discovered that hulls were good for cattle food. At any rate, cows ate them with avidity, and analyses proved that they had the feeding value of low-grade hay. So the mills now get from $4 to $10 a ton for hulls which are worth about $1 to $2 per ton as fuel.

The cotton-seed soap stock in the early days was almost thrown away. Much was made into woolen and scouring soaps. About 1877, a bright near-chemist mixed some of this soap with soda ash, and made it into washing powder. The advertising man made a virtue of its yellow color, and the "twins did the work." Now, the soap stock is used largely as a source for white distilled fatty acids and glycerine, while the residual tar from the stills forms a base for paint and roofing materials.

The chemist's greatest service to the industry has been in the refining of the oil. Beginning with tests for acidity, followed up by laboratory refining tests to determine loss and color, and finally bringing into use the tintometer for measuring the color against standard glasses, the commercial practice has been put on a higher and more substantial basis.

The careful and scientific application of bleaching materials and selection of the oil has done much towards the development of the lard compound industry. The greatest factor in the advance of the industry as a whole has been the development of methods for deodorization and improvement of the flavor of the oil. The flavor of an alkali refined oil is largely dependent on the seed from which it is made. For this reason it was practically impossible to obtain a uniform oil. Bleaching with fullers' earth helped but little. Even the best oils made from selected crude and careful handling were open to objection. Certain volatile principles made a disagreeable odor when the oil was used for cooking, and created natural prejudices. Now all flavors are absolutely removed, and the resultant product is as pure as granulated sugar, regardless of the kind of crude oil from which it has been made.

The latest contribution has been the hydrogenization of the oil which converts it into a solid fat by the introduction of hydrogen into the molecules of the unsaturated acids. This enables the manufacturer of cooking fats to turn out compounds consisting entirely of vegetable fat, which are fast displacing the mixtures of oil with animal fats formerly employed.

The improvements given by the chemist to the cotton-seed industry may be summarized as follows:

I—Putting the refining of crude oil on a more rational basis.

II—Preventing loss in manufacture by making a physical audit by analytical methods of the work of mills and refineries.

III—By analyses of products their values have been shown, and the commercial practice has been placed on an accurate foundation.

IV—By improving refining methods, practically all cotton-seed oil, regardless of section, or season, has been converted into one of our most valuable food products, and the residue worked into valuable by-products.

V—By the new process of hydrogenation wholesome edible fats of the consistency of butter and lard are now produced entirely from what will probably continue to be our cheapest vegetable oil.

VI—While the chemist has worked to improve the manufacturing side of the industry, he has been the means of putting something like $125,000,000 every year in the hands of the farmers; or, in other words, he has added ten to twelve dollars to the value of the crop for every bale of cotton grown and has made possible an industry which provides means of livelihood for the thousands of people in hundreds of factories and on the road making and selling the products.

24 Broad Street, New York

CONTRIBUTIONS OF THE CHEMIST TO THE CEMENT INDUSTRY

By G. S. Brown
President Alpha Portland Cement Company

Portland cement was manufactured in the United States in a small way 40 years ago. It occupied, however, a very minor position among the industries of this nation until the beginning of the present century. At this time the production of Portland cement is not far from 125,000,000 barrels, or 20,000,000 tons, per annum, and is, perhaps, next to the manufacture of iron and steel, the manufacturing industry which gives to the railroads their largest tonnage.

It is safe to say that the tremendous advance made in this industry has been, for the most part, due to the zeal and knowledge of the chemist.

Portland cement has been manufactured in Europe for very many years and in the latter part of the 19th century was imported into the United States in large quantities. The small amount of Portland cement manufactured in the United States at that time was of irregular composition and of, perhaps, doubtful quality; on this account there was instilled into the minds of the users of cement a strong prejudice against Portland cement of American manufacture.

Prior to 1890, investigations made by some of those interested in the manufacture of cement in the United States, convinced them that with proper care it would be possible to make from the materials available in the United States just as sound a Portland cement as was made in Europe. These men turned the matter over to chemists, who were given entire charge of the manufacturing process. It was very soon demonstrated that American Portland cement manufactured in this manner was absolutely as good as the foreign cements which hitherto had enjoyed a much better reputation. There was still considerable prejudice in the minds of the users of the cement and in the minds of engineers and architects; they argued that, while the short-time tests were satisfactory, there was nothing to indicate that the cement would give normal tests for longer periods of time. Further work by chemists proved, to the satisfaction of all reasonable men, that the constituents of American Portland cement and Imported Portland cement were not very different and that there was every reason to believe that the long-time tests would be just as satisfactory as the short-time tests were. This conclusion was amply demonstrated.

Having proven that it was possible to manufacture cement really of a better quality than that hitherto imported, the next step before the manufacturers was to reduce the cost, so that Portland cement could be sold to consumers at a price which would warrant them in extending its use and substituting it for other forms of construction. In the original factories the clinker was burned with oil. The kilns were short and the process was very wasteful of fuel. Along towards the end of the 19th century the price of fuel oil began to go up and reached such a point that the life of the cement industry in the United States was seriously threatened. Again recourse was had to the chemist, and after many experiments the system of powdering coal and burning it in kilns was perfected. This powdered coal took the place of fuel oil and resulted in a very marked reduction in the cost of manufacturing cement. Further than this, experiments were also conducted along lines indicated by theory and longer kilns were built, this again effecting a reduction in the cost of cement.

Many other reductions in the cost of the manufacture of cement were made by reason of the investigations of the chemist, probably the most important being that of handling the raw material in large quantities direct from the quarry. This method took the place of the old scheme, whereby the stone of different compositions was gathered in separate bins and then distributed in proper quantities throughout the mill. The present practice is to mix the raw stone in the quarry, thus greatly reducing the cost of handling. So much for the manufacturing itself.

In the realm of the use of Portland cement the chemist has also done much. He has been particularly active in educating those who use cement to the necessity of seeing that the aggregates used with the cement are of proper quality. He has also given a great deal of time to the development of specifications which will protect the user of cement. Originally, each engineer had his own specifications and many of them were most peculiarly and wonderfully drawn. The energetic efforts of the chemist practically eliminated all of these freaks and we have today, through his efforts, standard specifications which insure to any user of cement an absolutely sound article.

Time would fail me to go into the detail of all the problems which have come up in our business and which have been successfully solved through the efforts of the chemist. Careless manipulation in mixing concrete often resulted in walls that were not water-proof. While it is easily possible, with careful attention to the aggregates and mixing, to get an absolutely water-proof concrete wall without the use of any so-called water-proofing, the fact remains that in the hands of the ordinary user of cement proper care may not be taken. The chemist, therefore, developed a water-proofing material which, when added to the concrete, prevents water from seeping through.

Problems in connection with the storing of clinker, sorting of cement, the operation of our power plants, quarry conditions, etc., all have been referred to the chemist and by him put in process of solution.

The fact that the chemist is responsible for the quality of the cement to such an extent that he controls the operation of the mill, is largely advertised by at least one of the larger cement manufacturing companies in the United States.

Easton, Pa.

CONTRIBUTIONS OF THE CHEMIST TO THE SUGAR INDUSTRY

By W. D. Horne
Consulting Chemist

Chemistry as a science has contributed so much toward the development of the sugar industry from the beginning that the association has been a continuous one and cannot be looked upon as having been abruptly formed at any particular time, but rather as having been the principal factor in the development of sugar manufacture.

Thus the influence this science has exerted upon the industry during the past quarter century should be viewed in relation to what has preceded and what will follow. Much of what chemistry is doing now is the development of earlier work and will continue to exert its influence upon the future. Every department of the industry has long been under searching chemical investigation in almost every detail. Agriculture, manufacture, refining and utilization in the arts have called for chemical assistance and have received noteworthy aid. Very many new processes have been developed, better methods of analysis have been devised and theoretical knowledge of the constitution of the sugars has been substantially advanced. A vast literature is maintained on the subject of sugar, the main division of which is chemical. The International Commission for Uniform Methods of Sugar Analysis, composed of leading sugar chemists from the principal sugar-producing countries of the world, has done a great deal of good work in revising analytical methods, prescribing standards for apparatus, calculating working tables and generally supervising the field of sugar analysis.

Emil Fischer introduced the use of phenylhydrazine as a reagent in studying the theoretical molecular constitution of the sugars. This reagent's property of reacting with the aldehyde or ketone group of a sugar molecule and the adjacent alcohol group has rendered the highest service in studying the constitution of the sugars, as pursued for many years by Fischer, Herzfeld, Mulliken, and many others.

The development of sugar in the cane has been carefully studied by Prinsen Geerligs in Java and the occurrence of the nitrogenous constituents in the beet by Saillard in France, not to mention an almost endless series of similar investigations by other chemists in every branch of plant physiology and development. The influence of soil composition and the effect of fertilizer ingredients has also received detailed study, including the remarkable effect on plant development caused by the action of minute quantities of manganese in the soil upon the enzymes in the growing plants. A great deal of work has been done on the development of new varieties of cane through raising seedling plants and selecting, largely through chemical analysis, the best individuals for further propagation. Thus the famous D 74 has been developed in Demerara and equally good varieties in Java and other countries. In Java, a few years ago, the sugar industry was threatened with destruction through the prevalence of insect pests and other troubles which beset the cane with accumulating force. The development of new varieties through chemical and biological work alone reclaimed the industry and placed it upon a very profitable basis.

In the manufacture of raw sugar, the past quarter century has seen great advance through bringing factories under chemical control, and the cane industry has caught up with and surpassed the beet industry through its scientific development on these lines. The consumption of sugar in the United States has risen from 1,500,000 tons in 1890 to 3,750,000 tons in 1914 and the per capita consumption from 54 pounds to 84 pounds per annum. This has been partly due to the cheapening of sugar through scientific management in its production, raw sugar having fallen from 2.88 cents per pound (without duty) in 1890 to 2.03 per pound in 1914, and this, too, in spite of a rise in price of all other food staples, averaging considerably over 15 per cent.

In making raw sugar the proper defecation and clarification of the juice are chemical matters of first importance and during twenty-five years great improvements have been made in the double carbonation process both for beet and cane, the use of sulfitation of the thin carbonated juice, and the use of phosphoric acid and its salts as additional defecating materials. Kieselguhr has been introduced by Wiechmann as a clarifying agent and is now being used more and more extensively, especially since the development of the great Lompok deposit in California. Raw sugar factories are now producing white sugar directly from cane as well as from beet, due to chemical investigations of the matter and chemical control.

Raw sugar factories are now generally able to sell their molasses instead of throwing it away, because of chemically developed methods of converting it economically into alcohol, cattle foods when mixed properly with bagasse, peat moss, etc., and into other useful products. The sugar is all recovered from beet molasses by the Steffens process of conversion into tricalcium saccharate, and the by-products from this are going into fertilizers, cyanides, etc. Wax is recovered from scums and the residues utilized as fertilizers in the cane fields. Paper is made from the unused fiber of the cane and another by-product has been improved by the chemical investigations of the manufacture of rum.

In sugar refining, due to chemical research, invention and control, progress has been made all along the line. Better methods of enclosing samples of raw sugar have led to better agreement in tests through preventing changes in moisture. The establishment of the Sugar Trade Laboratory in New York, under Dr. C. A. Browne, has placed the polarization of sugar samples for seller and buyer upon a satisfactory scientific basis, free from bias.

Well-equipped laboratories are maintained by all factories and refineries where routine testing and analytical work are carried on constantly and where investigations are made. The Bates polariscope with adjustable sensitiveness is a recently developed aid of great value to all this work. Anhydrous subacetate of lead, introduced by Horne, has simplified the polarization of impure solutions and greatly reduced the time and labor of making tests. New analytical methods are constantly being developed along with more convenient apparatus. The refineries have given up the use of blood as a defecating agent in favor of acid phosphates, and the tendency is towards the use of flocculating agents which will produce no objectionable side products. Certain solutions containing invert sugar are cleared of this constituent in the Batelle process of heating with sufficient lime to destroy the invert sugar without harming sucrose. The Weinrich dry-lime process undertakes, by treating concentrated impure sugar solutions with pulverized lime at low temperatures, to effect a nice differentiation between organic non-sugars and invert sugar, whereby the former are largely removed along with some salts and most of the color, without affecting the valuable invert sugar. Progress has been made in electric defecation, but objectionable features of expense still await surmounting. Liquid sulfurous acid has to some extent beneficially replaced the gas, while the hydrosulfites of soda and of lime are used by many in massecuites and in syrups for improving color and yield. The practice of boiling back the syrups from previous massecuites has greatly developed, due to the increasing facility in testing all products in the laboratory and the increased precision of work possible because of this more intimate knowledge of the purity of every part of material in operation. Crystallization in motion has been developed to a fine point with great increase in yields. A more thorough exhaustion of the sugar from molasses has been arrived at, partly through the light thrown on this subject by chemical investigations such as that made by Prinsen Geerligs on the subject. Potash salts are more thoroughly removable through the permutit process which employs alkaline silicates similar to the natural zeolites for the purpose. Water supplies can be purified by the same process. New dyes have been developed to take the place of ultramarine, sometimes used to give a certain tone of white to some refined products.

The treatment of bone-black has been improved by the gentle oxidation obtained in the Weinrich decarbonizer. The increasing price of bone-black has led to the invention of various carbonaceous substitutes, among which can be mentioned Norit or Eponite favorably reported upon by the late Dr. Strohmer, and which its manufacturers claim to be capable of yielding white sugar direct from cane juices. Patterson has contributed materially to our knowledge of the composition of bone-black, but much remains to be learned concerning this material.

The last 25 years have witnessed the giving up of the attempt to commercialize sorghum sugar and the enormous development of the beet sugar industry within the United States, in both of which credit falls to Dr. Wiley, aided by many other well-known chemists.

What chemistry will do for the sugar industry in the future is a question of deep interest, and the answer will probably be found in simplified processes of defecation, cheapened materials for color removal, etc., more energetic chemical treatment of low-grade intermediate products and a better utilization of such by-products as are inevitable. The service of chemistry in the past leaves no misgivings for the years that are to come.

175 Park Avenue, Yonkers, N. Y.

CONTRIBUTIONS OF THE CHEMIST TO THE INCANDESCENT GAS MANTLE INDUSTRY

By Sidney Mason
President of the Welsbach Company

No article more strikingly emphasizes the importance of the science of chemistry than does the incandescent gas mantle, which owes both its inception and development, up to the towering output in the United States alone of upwards of 80,000,000 mantles annually, to the untiring effort of chemical research.

This industry, founded on the remarkable discovery and invention of Baron Carl Auer von Welsbach almost thirty years ago, has progressed along a trail blazed by the Chemical Engineer, Baron Auer, a chemist and scientist of world-wide reputation, who having as a lad been engaged in a scientific study of the rare earths, observed the phenomena that suggested to him a new system of gas illumination.

Previous researches of the rare earths by earlier chemists stimulated his desire to work in this field, which he undertook at the beginning for the purpose of contributing to the knowledge of this branch of chemistry, but which culminated in his demonstrating that a vegetable or organic fiber could be perfectly reproduced in mineral form by certain rare earth oxides sufficiently coherent and attenuated to become brilliantly incandescent in a non-luminous gas flame.

By patient and persistent chemical research for a period of years, the Welsbach gas mantle eventually reached a state of perfection which crowned the work of the inventor with commercial success. The spectacular discovery that a mantle made of thoria with a small admixture of ceria would increase the light-giving efficiency of previous mantle compositions more than three-fold, provided the impetus necessary for this purpose.

The thoroughness of the work and the investigations of Baron Auer are indicated by the fact that although the last quarter of a century has brought much enlightenment into the field of rare-earth chemistry, there is, however, today no satisfactory substitute for his basic invention.

Originally the rare earths had never heretofore been produced in great purity or in large quantities, and the science of chemistry and the research of the chemist was called upon to remove many obstacles in this direction before the industry was successfully launched. Many complex problems were undertaken and solved before an efficient manufacturing process, which is, of course, absolutely essential to the economic development of the incandescent gas-light industry, was attained.

It was early found that much depended upon the satisfactory and uniform character of the organic or vegetable fiber which was to be reproduced in mineral form in the incandescent mantle. The deleterious influence of impurities entering the light-giving body through this channel was soon demonstrated, and bleaching and cleaning processes had to be refined and perfected until a product of the required degree of purity was produced. It was soon discovered that the length of fiber or staple of the mantle fabric had much to do with the strength and durability of the finished product. Long staple or Sea Island cotton was in demand for this purpose, but the longer fibered ramie or China-grass was later made use of after it had been finally degummed, bleached and washed, a problem successfully accomplished by chemical research. These developments made possible the inverted or pendant type of incandescent gas burner.

The mantle manufacturer has held before himself for many years certain ideals towards which he has earnestly striven. Among these may be mentioned: strength with elasticity, high and maintained candle power, preservation of color and absence of shrinkage. A realization of these ideals seems finally to have been met in the mantles made from the bundle of homogeneous elastic, spring-like fibers known as artificial silk. Chemical science was engaged for a generation in the solution of this intricate problem, but even after a satisfactory quality of artificial silk had been produced, long years of patient research were needed before the incandescent mantle chemist was able to utilize this material in the preparation of an ideal mantle, and the final successful solution of this problem ranks high among the chemical accomplishments of this industry.

The protective coating, which carries the finished mantle from the factory to the consumer, has always been an item of great importance. At first incandescent mantles were coated by dipping in an alcoholic solution of shellac, which was made slightly flexible upon drying by the addition of a gum, or non-drying oil. The development of the nitrocellulose industry, and the invention of soluble cotton opened up a new field for the mantle maker, and the knowledge gained of the many varieties of nitrocellulose and their numerous solvents, together with the ability to control such characteristics as viscosity and hygroscopic effects, has now made it possible to prepare collodion solutions of almost ideal qualities and adapted to the ever-increasing variety of incandescent mantles.

All of these have been chemical and physical problems demanding research work of the highest order, and to the science represented by the chemist must be credited the present state of efficiency and economy of the incandescent gas light which bears the inventor's name "Welsbach."

Gloucester, New Jersey

CONTRIBUTIONS OF THE CHEMIST TO THE TEXTILE INDUSTRY

By Franklin W. Hobbs

President Arlington Mills and Past President American Cotton Manufacturers' Association

Chemistry has made many and varied contributions to the textile industries and in the brief space of this article it will be possible to mention, briefly, only a few of the most important.

Among the primitive races the use of colors undoubtedly preceded the use of textiles and it is probable that the earliest fabrics were colored with stains obtained from fruits and plants. We can imagine that by progressive steps it was found that some stains faded or washed out quicker than others and there was a gradual selection of those found best. Then came the discovery of the influence of heat and boiling, followed, perhaps accidentally, by the knowledge that certain salts precipitated some dyes and that cloths impregnated with these salts retained their colors longer. This discovery of mordants was perhaps the first real point of contact between chemistry and textiles. The date is unknown, but we do know that alum and iron salts were used by the ancient Egyptians.

Bleaching was also known to the oldest peoples. It was first known that cloths of linen or cotton became whiter when dried in the sun and sun bleaching became a common practice. Then came the development in the use of soaps and alkalis followed by the discovery of the bleaching property of chlorine. After this came the use of electrolytic chlorine, liquid chlorine and peroxide of hydrogen. The use of chlorine, of course, is not adapted to wool, but in early times the use of sulfur in bleaching wool was known and peroxide of hydrogen also is now used on that fiber.

Improvements in methods of dyeing have gone hand in hand with chemical progress. The introduction of mordants already mentioned widened the range of available colors. Insoluble colored salts such as tannate or iron, chrome yellow and Prussian blue were made use of and the active principles of some of the natural dyes were separated and purified. The reducing action which takes place during fermentation was utilized at a very early date in the dyeing of indigo, and the fermentation vat is still in use.

The greatest advance in the chemistry of dyeing came in the production of Mauve by Perkin in 1856, which was followed by the marvelous development of the coal-tar dyestuff industry. This discovery is said to have led to the investment of $750,000,000 in the coal-tar industry and has revolutionized the production of dyestuffs. Many of these colors are fugitive, but faster colors have been gradually produced and there are now fully one thousand brands on the market from which to choose. Of course many wool colors are not adapted to cotton and *vice versa.* There is an unquestioned superiority in many of the artificial colors over most of the so-called natural dyes.

The effect of synthetic alizarine upon the raising of madder was profound, for, as a result, a whole industry was destroyed. None the less startling was the discovery of synthetic indigo which was achieved after long endeavor and great expenditure of money and affected indigo-growing countries like India very greatly. As is often the case with great discoveries, loss comes to some in the readjustment, but in the end the world, as a whole, gains.

To chemistry and the research of chemists all over the world are due these great advancements in the knowledge and preparation of dyestuffs, and, as a result, a new industry unknown through all the ages has now been developed. In this connection, showing what chemistry has done, it is interesting in passing to note that the "Purple of Tyre," the dye used on royal robes in ancient times and which was obtained a drop at a time by killing small shell fish, has been analyzed and reproduced as a brominated indigo compound. The romance of the ancients has become a chemical formula of the moderns!

One of the greatest discoveries in its effect on the cotton industry was that made in 1850 by John Mercer of the process now known as "Mercerization." By a strange chance, however, he simply found that the treatment made cotton yarns and fabrics stronger and gave a greater affinity for dyes, but he did not notice that the process when properly carried out under tension produced luster. For more than forty years this process was little used and little appreciated. It was not until about 1895 that the great increase in luster due to mercerizing under tension was appreciated and its commercial advantages realized. Since then the art has gone forward by leaps and bounds, and today the production of mercerized cotton yarns and cloths is enormous, and has had far-reaching effects on cotton textiles. In many ways it marks the greatest advance in recent years in that branch of the textile industries.

Artificial silk is another great contribution chemistry has made to textiles. This was invented by Count de Chardonnet and was first exhibited in Paris in 1889. Development was slow and at first, from a financial point, disastrous, but now the annual production of artificial silk is fully 20,000,000 pounds. There are various processes—collodion, gelatine and viscose. The viscose process now seems to command the field and is developing rapidly in quantity and quality produced. Here is a case where common wood pulp worth a few cents a pound, by a touch of the chemist's art, is changed to a beautiful silky-appearing yarn worth from $2.00 to $3.00 a pound. An entirely new field has been opened up and its development has just begun.

Weaves, fabrics and patterns are numberless, but have reached a point where there is little that is really new or unknown. The greatest advances in textiles in the future must be along chemical lines. Coal-tar dyes, mercerizing, artificial silk—these and many others are already accomplished facts. The next steps rest in your hands and it is to the chemists we must look for the future developments.

78 Chauncy Street, Boston

CONTRIBUTIONS OF THE CHEMIST TO THE FERTILIZER INDUSTRY

By H. Walker Wallace

Manager General Sales Department, Virginia-Carolina Chemical Company

In considering what the chemist has done for the fertilizer industry we are dealing with a subject intimately connected with the culture of the soil, and while valuable services have been rendered in other directions it must be admitted that the most valuable achievements have been those which have had a direct bearing on agriculture, that noble calling which is the foundation of all industry and the very backbone of the nation itself. Any contribution, therefore, which has advanced the condition of agriculture has indirectly benefited all avenues of trade.

The science of chemistry has played a most important part in building up various industries which are dependent on the products of the soil, but perhaps no service has been of so much value to agriculture as that which has caused the development of the fertilizer industries of the world. The tremendous storehouses of plant food accumulated through the ages have been made useful by the chemist, who has found means of converting them into mixtures which make it possible to produce the larger crops made necessary by the ever-increasing population. Thus the tremendous accumulations of natural phosphates in this country and elsewhere, the large deposits of potash salts in Germany and the nitrate beds of South America have all been converted into useful products. The very air we breathe has been utilized in producing nitrogen compounds in suitable form for plant nutrition. In addition to the various supplies of raw materials furnished in nature, large quantities of refuse substances from the various industries have been collected, treated chemically and utilized in the manufacture of fertilizers.

Seventy-five years ago the fertilizer industry was unknown. Liebig was the first to study the chemical composition of the ashes of plants and to point out the necessity of supplying plants with mineral food; he conceived the idea of dissolving bones with sulfuric acid and thus rendering the phosphoric acid soluble, in which condition it could be more readily utilized by growing plants. This, then, was the real beginning of the manufacture of superphosphate fertilizers.

The treatment of mineral phosphates with sulfuric acid, however, originated with Laws, who took out a patent for the process in 1842 and established a factory, from which time the commercial production really dates.

During the first years development was slow, but in the past thirty years there has been a steady growth until at the present time the manufacture of fertilizers has reached enormous proportions in the eastern part of our country. In the year 1900 there were produced in the United States alone 2,200,000 tons and in 1913 the production had increased to 6,800,969 tons.

In the building up of this large industry what then has been the rôle of the chemist? In a brief statement it is impossible to tell all that the chemist has done, but a few of the important features may be summed up as follows:

1—He discovered the necessity of the industry by studying the composition of soils and plants.

2—It was the chemist who first suggested the production of superphosphate and established its manufacture.

3—The process of manufacture has been gradually improved so that the insoluble phosphoric acid has been reduced from two or three per cent to a fraction of one per cent.

4—He was responsible for the manufacture of sulfuric acid, which is necessary for the production of superphosphate.

5—He has produced a double superphosphate containing from 45 to 50 per cent available phosphoric acid.

6—His researches have made it possible to convert many waste products into valuable plant food constituents, which are utilized in fertilizers.

7—The nitrogen of the air has been combined and converted into forms suitable for plant nutrition.

8—The chemist has worked out processes for saving the nitrogen in flue gases and coke ovens and converting it into sulfate of ammonia.

9—He has worked out formulas and blended the various fertilizer constituents into the compounds best suited for different soils and crops.

Not only has the chemist been of great assistance in working out the initial problems of plant nutrition and the production of suitable fertilizers, but his services are indispensable in the regulations of the operations of the factory. In these days of close competition and rigid government inspection, profits may be easily turned into losses or goods confiscated by the state inspectors because of unsatisfactory analyses. The manufacturer must, therefore, have able and competent chemists to do his work or serious consequences will result.

In fact, the whole manufacture of fertilizers is intimately associated with chemistry and largely dependent on it for its existence. Notwithstanding the large measure of success obtained in the past, there are still new problems to be worked out and the chemist will not have done his part until the science of fertilization is thoroughly understood and he has made "two blades of grass grow where but one grew before."

Richmond, Virginia

CONTRIBUTIONS OF THE CHEMIST TO THE SODA INDUSTRY

By F. R. Hazard

President The Solvay Process Company

The rôle of the chemist in industrial operations is to answer the question "Why?" Why did the ancient Egyptians use straw in making brick? Until very recently the true answer to this question remained unknown, but with the true spirit of investigation of the trained scientist, Mr. Acheson has quite recently determined that the action of vegetable acids upon the clay creates a change, probably both physical and chemical, which adds enormously to its tensile strength. Thus one of the secrets of possibly the most ancient of all industries has been finally brought to light and the production of Egyptianized clay has been made possible with as yet unknown benefits.

This instance is but typical of the questions which arise in constantly increasing numbers in the complex industrial operations of our time. The chemist is the enemy of the rule-of-thumb methods. He is not content to accept the superstitions and prejudices which have been handed down in all industry, but seeks to ascertain the causes underlying the effects which, in some cases at least, are produced with a considerable degree of regularity by these rule-of-thumb practices. He is willing, in a truly scientific spirit, to take the known effects and to carefully examine them, seeking constantly the answer to the eternal question "Why?"

It is only within the past twenty-five or thirty years that the chemist has been admitted as an important member to the manufacturing staff in our modern industrial life. It is well within the memory of many of us that the master teaser in a glass factory had many strange and useless additions to the batch, and sometimes even murmured incantations while mixing it, or chose the dark of the moon, or had a rabbit's foot in his pocket, thinking that by these precautions he would obtain good results. At that time too often the managers and owners of the business knew very little about the practical operation. They relied absolutely upon the secret formula brought to their plant by the master teaser, and, in fact, a capable man in this position not infrequently made capital out of his formula and so obtained for himself a more important position at some other plant. In many other industries similar conditions existed; in other words, the manufacture of most of our products was then carried on by the rule-of-thumb method, and the question "Why?" remained unanswered.

Under these circumstances it is easy to see that the advent of the chemist was attended with great difficulties. He was regarded as their natural enemy by superintendents, and was looked upon with distrust by workmen. His experiments were ridiculed and not infrequently were purposely interfered with, so that their results would be without value. Thus, early in his introduction into the industrial field, it became absolutely necessary for the chemist to tell the workmen, the superintendent, the manager or owner, that none of them really knew their business, which unfortunately was the fact, but it is easy to see that it required the greatest amount of tact and diplomacy to make such a statement without giving so violent offense as to make his own position untenable and thereby practically destroy his usefulness in that particular work. It does, in fact, require unusual gifts outside of the scientific field to enter a manufacturing establishment and tell those who are conducting its operations that they do not know their own business, yet this is substantially the fact, even today, in many lines of work. The chemist must, therefore, exercise the patience of Job, he must have the wisdom of the serpent and the gentleness of the dove; he must be persevering and constantly alert to see the first signs which will lead him toward the answer to his question.

What has been accomplished by the chemist in industry during the last few years would require too great a space to catalogue. There is not a single field of industrial enterprise in which he has not made a notable mark. The synthetic production of indigo, followed by all the other developments in the color industry, is only one of the great achievements of the age. Metallurgical chemistry has absolutely revolutionized the manufacture of iron and steel. The cyanide process has made available ores of the precious metals which could not otherwise be economically worked. The chemistry of the animal fats and acids has made possible the production of enormous quantities of glycerine in connection with the manufacture of soap. The so-called chemical industry, including the production of alkalies of all kinds, acids, bleaching powder and the allied products and by-products, has built up an enormous industry which, in fact, lies at the basis of practically all other industries.

The field of the industrial chemist, though already broad and comprehensive, is constantly growing in all directions, just as the ripple on the surface of a pool created by throwing in a stone rapidly spreads over the entire surface. The opportunities before him are by no means exhausted. Every one of the interrelated industries of our modern life has its chemical problems. In each one of them the investigating mind finds many questions, correct answers to which will add much to the profitable operation of each one.

As an illustration of the delicate position of the chemist toward the manufacturer, the following is taken from our own experience: About twenty-five years ago a soap-maker complained that 58 per cent alkali purchased from us was not as good for his purposes as 48 per cent alkali imported from England. After considerable correspondence it developed that his method of ascertaining this peculiar fact was to take, say, 100 lbs. of each quality of alkali, dissolve each by itself in about a barrel of water and then determine the specific gravity of the solution by means of a Twaddle hydrometer. The 48 per cent alkali gave a somewhat greater specific gravity, and he thereupon concluded that it was a superior article. As he was one of our important customers and a somewhat difficult man to deal with, it became necessary to convince him by his own methods that his conclusions were not correct. We prepared samples of several different kinds of alkali, also of common salt and of sulfate of soda, and, using the same hydrometer, we determined the density of each, whereupon it was found that on his theory it was an absolute waste of money for him to purchase alkali of any kind as ordinary commercial sulfate of soda showed a considerably greater specific gravity than any of the other solutions. When confronted with this actual test, made on the same scale and using the same instrument as he had been accustomed to employ, our customer acknowledged himself convinced, and continued for many years thereafter to make his soap by the use of our 58 per cent alkali.

Only last year, to show that the knowledge which a chemist can contribute is still of value, a complaint was made by a glass-maker that the 58 per cent alkali furnished to one of his works was inferior to that furnished at another. Correspondence developed the fact that the workmen at one plant were also employed in handling lime and that the ventilation of the plant was not very good, while the conditions at the other plant were much better. The chief complaint was that the men in the one plant suffered seriously from sores; in fact, some of them were quite disabled. A personal investigation by one of our representatives showed that the unfortunate men were employed first in handling lime and then in unloading alkali, which was in bulk. The weather being quite warm and the exertion by no means easy, these men were establishing upon their own persons miniature caustic soda plants, and the resulting soreness and tenderness of the skin, if neglected, as was too often the case, led to rather serious conditions which required a long time to heal. An elementary knowledge of chemistry would have been sufficient to ascertain the cause of the difficulty.

Although much has been accomplished during the past fifty years, although the chemist has now found his proper place in practically all industrial operations, there still remains an enormous amount of ignorance to be overcome, a fund of ancient superstition to be vanquished, and a field of almost unlimited possibilities to be explored, in which the chemist of the future will find answers without number to the question "Why?"

SYRACUSE, N. Y.

CONTRIBUTIONS OF THE CHEMIST TO THE LEATHER INDUSTRY

By William H. Teas
President Marion Extract Company

Although one of the most ancient of industries, and involving as it does chemical reactions, the leather industry has, in only comparatively recent years, received the attention of chemists. The record of the accomplishments of the chemist in this industry during the past twenty-five years will comprise most of the advance along chemical lines that has taken place in the industry. The advent of the chemist in the leather industry was induced by desire to effect economies in raw materials; research, and improvement in methods became a secondary effect of the chemist's presence in the tannery, but success in the primary effort for economy was responsible for secondary effects, and for the now very general custom of laboratory control of the tannery.

The leather industry is divided into general divisions of vegetable and mineral tannages, and each of these has been subdivided into many specialized industries developed by the product demanded, and the use of the raw material suited to the product. In general, the tanning agents used, the oils, greases, finishes, etc., have in themselves been the chemists' fields, and in these and in the methods of application the chemists have found their work.

The chemist has indicated improvements in the soaking and preliminary preparation of the raw skins, so that a saving of the costly hide substance has resulted; his work in selecting the proper depilating materials, and in improving methods of their application has resulted in economy and in improved products. Practically all of the progress in deliming hides by the use of special preparations has been accomplished by the chemist; and to him is also due full credit for the results of investigations of the influence of the character of the water supply on the tanning operations. The utilization of by-products in this preliminary stage of tanning is another branch of effort in which the chemist has demonstrated his value.

In vegetable tanning, the chemist has improved the methods of leaching the raw tanning materials so that more of the tannic acid content has been made available; his laboratory work has shown the reasons for many of the rule-of-thumb methods of the practical tanner, and thereby afforded a means of anticipating and correcting conditions which would produce an unsatisfactory product. The standardization of tan-liquors, with the consequent tendency toward uniformity of product, could not have been accomplished without the work of the laboratory. The utilization of spent tan liquors formerly run to the sewer, by purifying and concentrating into a thick extract for mechanical tanning, is also a laboratory development; and the chemist is responsible for the progress so far made in the sewage disposal problems of the tanner.

The chemist has materially aided in the work of replacing the fast diminishing native barks, with combinations in proper proportions of foreign tanning materials, foreign and domestic extracts, so that physical characteristics and quality the leather produced under the new conditions is similar to the old product. The standardization of leather oils, greases and waxes, and the protection of the tanner against adulteration is a matter of course with any laboratory, but the standardization and protection was badly needed in the leather industry, and the accomplishment of the chemist in this line is fully credited. The development of special oils for leather work, especially sulfonated oils, and the application of the oils to remedy certain defects in leather, is due to the chemist; he is also responsible for special combinations of waxes and greases for stuffing leathers according to the requirements of the use to which the leather is put.

The development of the mineral tannages has been due almost entirely to the chemist; the chrome process was first suggested by a chemist and later its development to a commercial success was accomplished by a chemist. Ever since chrome tanning was started in a commercial way, the modifications of process and materials, tending to economy and improvement, have been due to chemists, so that one of the greatest accomplishments of the chemist in the leather industry, has been the process by which most of the light leathers of the world are tanned. The successful lubrication of the fiber of chrome-tanned leather has meant much to the utility and consequent popularity of chrome leather, and by means of saponifiable and so-called "soluble oils" the chemist has materially helped in this important factor.

Other mineral tannages, and tannages by formaldehyde and other aldehydes, have been worked out by chemists and brought to more or less commercial success as a result of laboratory work. Combinations of mineral and vegetable tannages for the production of leathers for certain purposes, are also the work of the chemist. Synthetic tannins, or at least products which give reactions analogous to the natural tannins, have been introduced by chemists, and their commercial value in some lines of the industry has already been demonstrated.

In the manufacture of tanning extracts from raw materials which grow in localities distant from the tannery locations, chemists have played an important part. Clarification processes introduced by them have, in some instances, increased the availability of some tanning materials, which, without clarification, would have a diminished economic value. Credit is also due the chemist for the production of special extracts, which have made possible the saving of time and labor in the production of certain kinds of leather.

In the production of patent and enameled leathers, of fancy leathers, and in the field of dyeing and coloring so important to light leathers, and in the numerous other departments of tanning, not mechanical, which space will not permit of particularizing, the chemist has been and is an important factor in product improvement.

The chemist in the leather industry has had to overcome the prejudice of the practical tanner against tanning theory, and without guiding precedents has been obliged to make his own standards, and develop his own ground work. Recognition of the value of the efforts of the chemists is evidenced in the vast increase in the number of tannery chemists during the past twenty-five years. And still further evidence is the establishment of a tanning school in which chemistry is the most featured branch in the curriculum; and also the definite plans for starting a national research laboratory to be supported by the industry, and to be devoted to research work in the chemistry of tanning.

Marion, Virginia

CONTRIBUTIONS OF THE CHEMIST TO THE FLOUR INDUSTRY

By John A. Wesener and Geo. L. Teller
Consulting Chemists

Flour may be defined as the fine white meal of the interior of the wheat grain, either by itself or mixed with a small proportion of finely ground wheat bran or wheat germ. Its quality depends upon the kind of wheat from which it is made and upon its freedom from bran and germ, which for the most part in the ordinary process of milling find their way into coarse by-products ordinarily sold as feed for domestic animals.

There are several types of wheat recognized in this country, the most clearly defined groups of which are soft winter wheat, hard winter wheat, spring wheat, durum wheat. There are many gradations between the first two of these classes and sometimes it is difficult to distinguish one from the other: both also include distinctly different types of wheat. The leading types of hard winter wheat are found in Kansas and Nebraska: the leading soft winter wheat section is in the Ohio Valley and northward with varying types scattered in different sections throughout the country. The flour from soft winter wheat grown on the Pacific Coast is for the most part different from that of soft wheat grown in the Ohio Valley. The chief home of the spring wheat is in Minnesota and the Dakotas, while the natural location for the durum wheat is in the semiarid regions of the northwest, east of the Rockies.

The wheat grain consists of three distinct parts: the outer seed covering or bran, the embryo plant, also called the germ, and the endosperm which contains the store of food to nourish the young plant. This latter, when crushed, produces white flour. Because of this make-up of the grain modern milling processes necessarily make several grades of flour from the same wheat. In milling, the wheat is first broken on rolls with grooves or teeth-like corrugations. These tear the bran apart and break it from the interior of the grain. If this separation could be made complete, the entire endosperm could be crushed into a pure flour of highest quality, and the remainder of the seed could be set aside for stock feed. As it is, some fine particles of bran always adhere to and go with the part that is wanted for flour. Purifying machines help to get rid of this and then the small fragments of flouring material are crushed between smooth or very finely fluted or scratched rolls. Some bran particles which still adhere are also crushed and torn into smaller fragments. The germ is rich in oil so that it holds well together and forms a little flake; this and the coarser bran separated from the middlings in the crushing are held on the top of a sieve made of silk or wire while the finer flour passes through. The crushing of the endosperm must be not so hard as to make it sufficiently fine at one operation for all of it to pass through the sieve or the bran and germ will be too finely powdered and will pass through with the flour. Such of the endosperm as does not pass through the sieve is again crushed by rolls. The processes of sieving and crushing are repeated as often as is necessary and a greater or less quantity of flour is produced at each step. A little flour is always made in the first breaking of the wheat. This is of the softer starchy part of the grain and is not of as high quality as that made from the so-called middlings, which are fragments of the endosperm too large to be called flour. The first middlings are very pure and require little more than crushing to make them into flour. The flour made from these is the highest quality of flour from the wheat: later crushings of the middlings contain more bran and contain a little more of the germ. These change the appearance of the flour and help to make it darker in color. The later crushings also include more of the harder part of the endosperm which is richer in gluten, in oil and in carrotin, which gives the characteristic yellow tint to fresh milled flour.

The several streams of flour which are produced in the mill by these successive crushing and bolting processes are combined according to their characteristics to form the various grades for the market. Flours from the same wheat have in general come to be divided into three grades which are designated patent, clear and low grade, the percentage of these grades differing with the varieties of wheat and milling ideas. Where all of these streams are combined in one grade, it is known as straight, or where all are combined, except a small percentage of the low grade, it is known as a long patent.

With any method of grouping there is a small amount of flour containing a large proportion of fine cuttings of bran and germ designated low grade that it is seldom advisable to combine with any of the other grades as the discoloring effect is out of proportion to its quantity.

There is no set rule for making these divisions and they are governed largely by local circumstances. Strictly speaking, it is very difficult to define just what a patent flour is, and many different qualities of so-called patent flour may be made from the same wheat, depending on how the several portions of flour are combined.

As among the several grades of flour from the same wheats, the patent—that which is whitest and freest from bran particles—will contain the least ash, the least gluten, slightly less fat and the most starch. None of the commercial grades of white flour contain any appreciable quantities of crude fiber or of other indigestible matter. The clear flour and the low grade contain more gluten or more protein, more phosphates and slightly more fat than do the patent or the straight grade from the same wheat. Since among American food products, protein is considered to be more costly than starch, clear and low grade flours should naturally be looked upon as having greater food value than patent flours. When taken by themselves, however, their products when baked are darker in color and bread from the clear and low grades have a stronger flavor which is not relished by all. The clear, when mixed with the patent to make a straight grade, does not show this objectionable flavor in the bread and the objectionable color is not so marked. In commercial bakeries the clear flours are mixed with rye flours in the making of rye bread. The gluten of the wheat flour is necessary to give volume to the rye loaf, for the proteins of the rye flour, while apparently of the same character and chemical composition as those of the wheat flours, do not, when made into a dough, produce the peculiar glutinous mass characteristic of the latter. Contrary to a general opinion, rye bread is not more nutritious than wheat bread for rye flours themselves contain much less protein than do wheat flours. Graham flour or unbolted wheat meal contains more protein, more fat and more mineral matter than the white flours produced from it, but it also contains much more matter which is indigestible.

White flour is pre-eminently the bread stuff of civilized man. With proper handling almost any sound wheat flour can be made into a palatable wholesome bread but there are wide differences in flour, and different flours require very different treatment. Flour is often pronounced poor for bread-making when it simply is not suited for the method used. For centuries bread has been made from wheat flours by fermenting the dough with some form of yeast. This fermentation has several purposes. As used at the present time, with white flour, it makes the bread more attractive, more palatable and more wholesome. This was, perhaps, the first step in the application of chemistry to bread-making, but even up to the present time, the full chemistry of it is not understood and it is less than a half century since the true cause of the fermentation was first pointed out. Fermentation, aside from producing gases to develop porosity of the dough and leaven the bread, plays an important part in softening the gluten so as to permit its proper expansion when put in the oven. It also assists in developing the proper flavor of the bread. The fermentation required to produce the best bread depends upon the flour and should be varied to suit the flour used. Soft wheat flours require little fermentation: hard wheat flours require more; and in all cases a clear flour from any wheat requires more fermentation than patent flour from the same wheat, partly because it contains more gluten and partly because the gluten present is more resistant to the mellowing influences of the fermentation. Soft wheat flours make excellent yeast bread when properly handled. They are not suitable for commercial bread makers because they make a smaller loaf of bread and less loaves to the barrel for the same amount of flour than do the hard winter or the spring wheat flours. Some of those who are familiar with the characteristics of soft winter wheat flours select the clear flour for yeast bread and get better results in all respects, except as to color, in so doing. They are especially adapted for the making of warm biscuit, of crackers and of pastry. This is partly because they contain less gluten and partly because they give products of better color. Hard winter and spring wheat flours are both well suited for yeast bread. They are also used with good results in the making of pastry and table biscuit by those who are familiar with them and therefore make a sufficiently soft dough and use other ingredients in the proper proportions. Durum wheat flours are exceptionally useful for the making of macaroni, largely because of the deep yellow color; also because of the peculiar toughness of the dough which becomes apparent on drying.

The characteristics which distinguish flour of the soft winter wheats from that of other wheats are a lower gluten content and greater starchiness; a whiter color; a softer gluten and a lower capacity for the absorbing of water in the making of dough. In general, the flours from the hard winter wheats are between those of the soft winter and the spring wheats, in these particulars, but there are some hard winter wheat flours which have more gluten than many of the spring wheat flours and the hard winter wheat flours often have a better water absorption capacity than the spring wheat flours. The durum wheat flours do not differ greatly from the spring wheat flours, either in the water-absorbing capacity or in the amount of gluten which they contain.

Baking powder biscuits have, to a large extent, superseded the old sour milk and saleratus product. Aside from the large sales of the baking powders themselves, the self-rising flour industry, where the baking powder is sold in the flour itself has, in recent years, developed enormous proportions, especially in the south. It has been made possible by the manufacture of low-price baking soda and high-grade acid phosphates. Soft white flours are chosen for self-rising flour and baking powder biscuit, partly because the trade using these articles in the greatest quantities is accustomed to a very white flour and demand it, and partly because the mellower gluten of the soft wheat acts promptly in a limited time with these leavening agents and does not require fermentation with yeast to make it sufficiently tender to offer little resistance to the proper expansion of the dough in baking.

Different wheats yield flours containing different proportions of starch and gluten and flours of different shades of color and of different baking qualities. From the manufacturer's standpoint it is highly important for the miller to keep his product and for the baker to keep his raw material uniform. Of recent years the miller has come to make much use of the chemist in selecting his wheat, and both rely upon him to know the character of the flour.

Normal wheat flour is not a dead inert matter, but is in many ways an active, changing, living substance. Freshly milled flour from new wheat bakes very differently than does the same flour after it has laid in storage for a few weeks or months. Bakers and millers have long recognized this and have provided for it in the handling of the material. The amount of storage required depends largely upon the length of time after harvest and apparently also upon the condition under which the grain has ripened and the completeness of its maturity at the time of gathering. During this storage, change takes place in the gluten or in some of the other nitrogenous bodies present, and also in the coloring matter. Under some conditions, too, the flour may become drier and thus have increased absorption. It was to overcome the defect of newly milled wheat flours and supply the demand for white flour and white flour products that modern flour bleaching and maturing processes were devised. It has long been known that when flour has been exposed to the air it quickly loses its yellow color and more recently it was found that when certain oxides of nitrogen and some other gaseous agents are mixed in small proportions with the air which comes in contact with the flour, the yellow color disappears almost instantaneously. The chemistry of the process appears to be a direct combination of the agent with the coloring matter, which coloring matter is carrotin: the new product is colorless, while the carrotin itself is yellow. When the agent used is an especially purified anhydrous chlorine, applied in the proper manner in minutely accurate quantities, there are changes other than color brought about in the flour which simulate very closely those changes which flour undergoes in long, favorable storage. Such flours not only produce a whiter bread, but a loaf of better texture and in many cases of greater volume. The gluten of these flours, being mellowed, will not require the extreme fermentation to produce satisfactory results that the same flours when fresh would have required to render their strong, harsh gluten sufficiently elastic not to offer undue resistance to expansion.

Of recent years, especially in England, various chemical salts have been proposed as additives to flour in minute quantities for the purpose of promoting the baking qualities of it. Up to the present time they do not appear to have met with great favor in this country.

Up to the time of the introduction of bleaching, flour making was looked upon as a purely mechanical process. Color as an indication of freedom from impurities became a distinguishing mark of quality and was the impetus for improvement in all departments of milling. Mechanical improvements in this direction, having apparently reached their limits, it was entirely natural that chemistry should step in and furnish the finishing touches. Even though industries manufacturing and using flours have been slower than others to realize the possibilities in this direction it is apparent that much has already been accomplished. We may summarize briefly as follows:

Chemistry assists in selecting and buying the grain; it helps to show the quality of the flour produced. It has supplemented mechanical processes of the mill and accomplished what had long been desired but could not be attained, in the improvement of color and baking qualities of the flour. By the introduction of baking powder products it has made possible many delicacies in the way of pastry and biscuit and has made possible the great self-rising flour industry. It has helped to explain the intricate process of the fermentation of bread dough, has pointed out the way to fit flour for it, and has unlocked doors for investigating problems of bread production, which have, as yet, opened only enough to permit a glimpse of a large space filled with interesting and useful possibilities.

Columbus Laboratories, Chicago

CONTRIBUTIONS OF THE CHEMIST TO THE BREWING INDUSTRY

By Gaston D. Thevenot
Consulting Chemist

Before we endeavor to ascertain what influences the chemist has been able to exert on the development of the brewing industry within the last 25 years, we must realize that brewing is not merely a chemical process in which chemical reactions in connection with mechanical appliances bring about all the changes from the raw material to the finished product, but that biological phenomena also play an important rôle. In fact, the biological side is of as much importance as the chemical one, so that the chemist who devotes his energies to the brewing industry must be just as well versed in the biology of microörganisms and bacteriological work as in chemistry itself, besides possessing a thorough knowledge of the practical and mechanical ends of the industry.

The influence of the chemist makes itself felt first in the selection and preparation of the raw materials from which the beer is made.

In the manufacture of malt, marked progress has been made. The old-fashioned methods of steeping the grain and of floor malting have largely been done away with. The introduction of aeration and agitation of the grain during steeping not only permits a thorough cleaning of the material, thus freeing it from the greater number of adhering microörganisms, but also furnishes to the grain some of the oxygen necessary for its ulterior sound germination. Pneumatic malting, which has generally taken the place of floor malting, permits an excellent regulation of those conditions of moisture, temperature and aeration which scientific investigations have found to be essential for the manufacture of a high-grade product. Lately the germination of the barley, at least temporarily, in an atmosphere of carbonic acid gas generated by its own germination has attracted considerable attention, as it supplies a high-grade malt with a considerable reduction of the loss of valuable substances otherwise incidental to respiration during germination.

Starch being the most important ingredient of barley malt, inasmuch as it furnishes most of the extractive matter as well as the alcohol of the finished beer, it was tried at quite an early date to substitute barley malt, at least partly, by materials richer in valuable starch and, if possible, of a lower cost. Only in the last decades, however, has the introduction of malt adjuncts become practically universal, in this country at least, and rice and various corn products are largely employed in conjunction with malt. The greatest progress has been made in the manufacture of corn products, as they are now made of a very high grade of purity, some practically free from oil, others prepared with great skill in such a way that the cooking process which was formerly necessary can be dispensed with and the material used directly in the mashtun together with the malt without any further treatment at the hands of the brewer. The great purity of these products permits of the manufacture of an extremely clean-tasting beer of special character which appeals greatly to the American consumer and which admirably suits the conditions under which beer is consumed in the United States.

Neglected for a good many years, the influences of the brewing water has of late been made again the subject of a thorough study and the effect of the different mineral ingredients of natural waters on malt, yeast, and beer has been closely investigated. Some of these investigations have led to quite remarkable results which have prompted chemists to treat brewing waters in various ways in order to either remove such mineral constituents as have an unfavorable effect on the character of the beer or add to them those ingredients in which they are lacking and which tend to improve the quality of the product.

An enormous amount of energy has been expended by the chemist on the explanation and scientific control of the mashing process and great strides have been made in this field.

The hydrolysis of the complex starch molecule and the nature of the various cleavage products formed have been made the subject of careful study; painstaking experiments have been carried out, new formulas evolved, and while our knowledge today of the action of diastase on starch is not final we yet have a clear insight into the hydrolysis of starch and are well able to regulate mashing conditions so as to obtain any desired degree of inversion and consequently to produce a beer of any desired composition.

The proteid side of the mashing process has not been neglected. On the contrary, it received all the more attention when it had been recognized what great importance the proteids possess for the nutrition of the yeast, the foam-keeping capacity, stability and brilliancy of the finished beer. Experimental investigations have demonstrated what special groups of proteids or their cleavage products furnish food for the yeast, what groups cause the formation of a creamy and lasting foam, and what proteids are responsible for the appearance of a haze or a turbidity in the finished product. The temperatures and conditions of acidity controlling the changes of the complex proteid molecule under the action of the enzyme peptase have likewise been studied thoroughly so that the brewer, armed with the knowledge which the chemist has provided for him, is well able to regulate his mashing operations and the subsequent treatment of the beer in storage.

Colloidal chemistry has begun to play an important part in all these investigations and with its aid several difficulties have been overcome which for years had baffled all endeavors of the brewery chemist. Thus it has been possible with the aid of lupulin in colloidal state and peptic enzymes to prevent the appearance of a proteid turbidity in pasteurized beer, even when the latter is kept at the freezing point for a long time or is actually frozen. This is of the greatest importance to the brewer in view of the fact that the American consumer desires above all an absolutely clear and brilliant beer which will retain this desirable appearance even when chilled to the extremely low temperatures at which beer is generally consumed in this country.

The progress made in the fermentation of the beer during the last decades has been of the first magnitude. First of all must be mentioned Hansen's remarkable discovery of the existence of the types of yeast which produce various sicknesses in beer, their isolation, and the study of the conditions under which they thrive, how they differ from the useful or culture yeast, and how their presence in beer may be obviated by the introduction of pure culture yeast propagated from one single cell. Not since the days of Pasteur's wonderful publications has the study of microörganisms been furthered to such an extent as by Hansen's classical investigations which have not only benefited the brewing industry but form the foundation on which rests all future study of microörganisms in general.

As every type of yeast behaves differently during fermentation and produces a beer of different character, the brewer is enabled to select the type best suited to his requirements, to propagate it from a single cell and absolutely free from wild yeasts or other foreign microörganisms, and to retain the character of his beer at all times.

The study of the activity of the yeast during fermentation has also received great attention and the discovery of the enzyme zymase as the agent causing the splitting of sugar into alcohol and carbonic acid has for all times disposed of the various fermentation theories which had been set forth for a hundred years or more. The study of other enzymes has not been neglected and their specific actions as well as their enormous influences in all malting and brewing operations have been firmly established.

Considerable attention is also due the investigations on the decomposition of albuminous matter during fermentation, it having been proven that, contrary to older theories, many by-products of fermentation, aromatic ethers and higher alcohols, such as amylic alcohol, are not cleavage products of sugar but of proteids. The discovery of the formation of the latter alcohol, while of comparatively little importance to the brewer, is no doubt of great value for other industries.

It is of prime importance that beer, through all of its stages of manufacture, be kept as free from contamination as possible, and the sterilization of brewery vessels or all implements with which beer comes in contact therefore received proper attention. A number of very efficient disinfectants have been invented for the purpose. The introduction of ozone as a sterilizer of the air in the brewery cellars and of the water employed for cleaning purposes is one of the latest developments in this field.

As far as the finished product is concerned, its clarification and sterilization have been given great attention. The important rôle which the proteids play in regard to the stability and brilliancy of the beer has been mentioned before. It was part of these investigations to determine what proteids were responsible for a more or less turbid appearance of beer and what means had to be employed to either restrict or prevent their formation during mashing or to eliminate them during the final stages of manufacture. It has been stated that this question has been successfully solved. Mechanical means of clarifying beer by freeing it from most of its suspended yeast cells by means of filtration through cellulose material have been greatly perfected and lately a filtration process has been introduced which removes all yeast cells or other microörganisms present by forcing the product through porous stone cylinders and which produces an absolutely sterile beer, capable of keeping perfectly unchanged for an almost unlimited period of time. The object of the latter process is really to do away with pasteurization which checks the development of microörganisms in the finished beer in the bottle by heating. The conditions yielding the most satisfactory results in preserving beer by pasteurization have likewise been studied and the methods greatly improved.

The large quantities of spent or waste material derived from brewing operations have, for a long time, attracted the interest of the chemist. The question of the disposal of spent grains was most easily solved and for a long number of years these spent grains have formed a valuable cattle feed. Their value for this purpose has been considerably increased since drying of the wet grains is resorted to, thus resulting in a stable article which can be kept in perfect condition for a long time and which is even suitable and actually used for export.

The enormous quantities of carbonic acid gas escaping during fermentation, which amount to several hundred thousand tons per year in all of the breweries of the United States combined, were next given attention. Part of this gas is now, after suitable washing, compressed and sold in liquid form, while another part is utilized on the brewery premises for charging the fermented beer with the gas required to impart to it the necessary life and to insure a sufficient head of foam. The latter process, the carbonating of beer, has been largely introduced and has resulted in a very great saving to the breweries in which the system is installed.

The third waste product which has attracted the attention of the chemist is the yeast, of which very large quantities are discarded and run to waste after each fermentation. Analysis showed that yeast is extremely rich in valuable proteids and phosphates, and many chemists have endeavored and quite a number have succeeded in manufacturing from the waste yeast an extract which in taste and nutritive qualities is at least equal to meat extract. By others highly valuable cattle feed has been prepared from yeast and it is to be expected that in a relatively short time almost all of the yeast now going to waste will be diverted into useful channels.

In the above paragraphs the achievements of the chemist in his relation to brewery operations could merely be touched upon. As in all sanely conducted manufacturing enterprises, it has been and is the chemist's ideal to get at the bottom of, and explain in a strictly scientific way, the principles underlying all phases of the entire operation and to evolve means of cheapening the manufacture of the final product. At the same time I wish to emphasize that it is the aim of the brewery chemist to assist in producing a sound and healthful article in which the factors of purity and quality are of paramount importance and rank first before all other considerations.

CONTRIBUTIONS OF THE CHEMIST TO THE PRESERVED FOODS INDUSTRY

By R. I. Bentley

Vice-President and General Manager California Fruit Canners' Association

A little over a century ago Appert, a French chemist, was awarded a prize by his government for discovering a process for preserving foods without the use of preservatives. Appert's process of hermetical sealing is the same in principle as that in use today by food preservers the world over.

The industry has grown to such wonderful proportions that the annual output runs into billions of packages and nearly every known variety of meat, fish, vegetable and fruit—to say nothing of various sundries—is preserved in tin or glass. Statistics show that New York City expends $150,000,000 annually for preserved foods—as much as that city spends for milk, bread and eggs combined for the same period. This gives some conception of the volume of the business and the extent and variety of the field that it covers.

A chemist having made the industry possible, it would be presumed that chemists would have more or less to do with the preserving of foods from that time on—but in the early days of the industry, in our country at any rate, preservers of foods had little or no scientific knowledge. Their business for the most part was done in a very small way. There was an air of mystery about the processes and each preserver very jealously guarded the methods which he had acquired by experience, or by purchase from some one who had the experience. Under such conditions the keeping quality was the primary consideration in the mind of the preserver—if the flavor or appearance received any consideration, it was merely secondary.

It is a question whether, up to 20 years ago, it ever occurred to a preserver of foods that he could make use of a chemist or bacteriologist in his business. It is a question also, if it had occurred to him, whether he could have found a man, excepting at very large centers, who could have assisted him to any material extent. It is also a question whether, without special knowledge of the industry, a chemist could accomplish much until some insight and knowledge of the business was acquired. If the chemist and bacteriologist gave any attention to manufacturers prior to 20 years ago, they confined their attention to industries other than that of the food preserver. The food preserver, however, having now started to avail himself of their services, is making up for lost time.

Reference will be made to the application of bacteriology to the industry as well as to that of chemistry. The two sciences are so closely related and interwoven in the preservation of foods that it is difficult to discuss the one without referring to the other. If an apology is necessary, your attention is called to the fact that the presentation of this subject is not by one of your profession.

It is impossible within the limits of this paper to go very much into detail, or to present any statistics for your consideration. In this general discussion, therefore, the application of chemistry and bacteriology for the benefit of the industry will be mentioned, and illustrations of such application will be given.

Chemistry has enabled the food preserver to get the best materials suited to his use. A very simple illustration is that of salt—used to a large extent in the preservation of vegetables. Formerly, the preserver considered it a matter of economy to use the cheapest grade of salt that could be purchased. The chemist has shown him that some salt on the market contains injurious materials and that its use affects both the quality and appearance of products. Chemistry having already determined what grade of salt is best suited to his use, on its delivery the chemist determines whether the preserver has received what was selected. In the item of solder also, chemistry has enabled the preserver to get those proportions of metals which are best suited to his use, and on delivery the chemist tells him whether he has received what he ordered.

The application of bacteriology has enabled the preserver to scientifically determine the best methods of processing. The bacteriologist has ascertained the forms of organisms which cause trouble and by means of cultures of the same and inoculation experiments he has determined definitely what times and what temperatures are necessary for sterilization in order to preserve the different products.

The preservers of corn probably had the first experience with bacteriology as applied to the industry, for they had more or less trouble with what was termed "sour corn." Ordinarily corn that was not properly processed would develop what the trade terms "swells;" *i. e.*, gases would be formed to such an extent that the heads of the tin cans would swell out—hence the name "swell,"—and ultimately burst; but in the "sours" no gases were formed and the preserver was completely at sea. While the corn men had experienced this in a limited way, it had not been of sufficient importance to warrant them going to any great expense in the matter of research—but one season it developed in such large proportions in the case of one packer that investigation was started. About the same time some of the California preservers experienced the same difficulty with their asparagus. The California people were fortunate in getting hold of the same bacteriologist who was investigating the matter for the corn people and at the same time the matter was put in the hands of a bacteriologist in California. What seemed almost uncanny to the California asparagus packers at that time was the fact that two bacteriologists working entirely independently of each other arrived at the same conclusions as to the methods of processing the goods in order to obviate the difficulty.

Application of the laws of chemistry and bacteriology has also enabled the preserver to improve the quality of his product. The preserver, before he was shown a scientific method of processing, whenever he had any trouble with his goods—no matter from what cause—subjected the same to heat for a longer period of time, with the result that the quality suffered. The bacteriologist having informed him of the time beyond which it was unnecessary to go, he now knows that if he has trouble he must look elsewhere for it. This has greatly improved the quality and flavor of his products.

Among the applications of chemistry that have given the food preserver an improvement in the quality of his products may be mentioned improvement in the color of some varieties of fruit, such as berries, by the enameling of the inside of the can; also the examination of the water supply of the food preserver and the elimination of the objectionable elements in the water or the securing of a new supply. The almost complete elimination of iron in the machinery which comes in contact with the canner's products is due to the chemist pointing out the fact that the source of darkening or discoloration of the products was caused by the affinity of iron for tannin.

The application of bacteriology has enabled the preserver to detect promptly possible spoilage and remedy it before any material damage is done. It is a common practice with most preservers to have their products examined frequently; for instance, in the manufacture of catsup, tomato pulp is examined daily; the bacteriologist determines whether this product is right or not before it has gone beyond the initial stage of manufacture.

Chemistry has enabled the preserver to arrive at more economical methods of manufacture, particularly in the saving of labor and eliminating or reducing waste. Many fruits and vegetables are made ready for canning by immersing them for a few seconds in a solution of caustic soda, after which the fruits or vegetables are subjected to the action of fresh water sprays. In this manner the peeling is removed at a great saving in waste and labor without affecting the flavor of the fruit and vegetables so treated. By this method riper, and consequently better-flavored fruit can be handled than by the hand method of peeling. This method is now used almost exclusively on some varieties and is far more cleanly and sanitary than the old.

The application of chemistry has enabled the preserver to improve the conditions under which he operates. The supervision of the boiler water supply of the cannery has resulted in the reduction of costs of generating steam by lessening the amount of fuel, and has lessened depreciation of plant by the elimination of boiler scale and consequent shortening of the life of the boiler. The modern canner does not attempt to feed his boiler with water that has not been declared fit by a chemist.

Chemistry has enabled the preserver of food products to utilize some of his waste materials. There are some fruits, for instance, that have to be treated to a preliminary manufacturing process. Much waste results from this method of manufacture, but the chemist has enabled the food preserver to utilize some of this waste, and what was previously a source of expense has now become a source of revenue.

The most notable application of chemistry in the matter of utilizing the by-products of a food preserver is that of the pineapple waste in the Hawaiian factories. More than 50 per cent of the pineapples received by the preserver were waste, the disposition of which was a heavy item in his expense account. A firm of chemists has worked out processes and methods for the recovery of the sugar values in this waste and proposes to furnish a syrup to the preserver, thereby almost entirely eliminating the use of cane sugar. These chemists have produced the syrup in the laboratory for the preserver on a small commercial scale. The syrup produced experimentally has been satisfactory both from a chemical standpoint and to the preserver as well. They have now about completed the erection of a small plant of a capacity of 50 tons of waste per day. Aside from the sugar value of the waste, it is expected that other products which will have considerable commercial value will also be recovered. If the larger commercial plant proves as successful as the experiment justifies the promoters in expecting, it will be very profitable both to the preservers and the chemists originating the process. It may be of interest to you to know some of the details of the business transaction between the chemists and the preservers. The chemists secured optional contracts from some of the largest producers of the waste in the Hawaiian Islands before even conducting their preliminary experiments, thus safeguarding the interests of the firm during the experimental period. If the small plant referred to is successful then it becomes binding upon this firm to erect a plant of sufficient capacity to take all of the waste of the preservers with whom contracts have been made, process the same and sell the sugar syrup back to the preserver at the equivalent of the market price for cane sugar. Each preserver shares in 50 per cent of the net profits as represented by his proportion of the waste furnished. The Hawaiian pineapple preservers will undoubtedly require the equivalent of $500,000 worth of cane sugar in 1915. It is expected that the recovery plant will return to each preserver syrup recovered from his waste equal to 90 per cent of his requirements.

It is said that the preserver of meats has the utilization of waste and by-products down to such a fine point that he turns everything but the squeal of the slaughtered animal into profit. The preserver of fruit and vegetable products does not even approach such a position, for there are thousands upon thousands of tons of waste that are a source of expense which by the application of chemistry will be made ultimately to bring in a revenue.

While there has been something of accomplishment in this direction, it is not entirely the fault of the food preserver that it has not been more extensive. Many a good idea has been partially developed by chemists and submitted to manufacturers, and owing to the chemist's lack of practical knowledge of the food preserver's business, and owing to the manufacturer's lack of technical knowledge of chemistry, failure has resulted. When a manufacturer has one or more failures which have been a source of considerable expense to him in the way of equipment, etc., he is not inclined to continue experimenting. On the other hand, no class of manufacturers is more progressive and more likely to put money into research work than food preservers—but they must have a few successes along with the failures.

Every new idea should be worked out first in the laboratory and then on a small commercial scale, so that the expense in case of failure will not be large—and even if the experiment is ultimately a success it is best to hold down the expense and perfect the process before trying it out on a large scale. If chemists would work on these lines with manufacturers, we are satisfied that the application of chemistry would accomplish great things, both for the chemist and the manufacturer. Under such conditions the preserver of fruit and vegetable products will, by the application of chemistry, be able to utilize all waste and even retain and preserve the bloom on the fruit and the spicy odor of it as well—and thus beat out the meat packer, who admits losing the squeal.

San Francisco, California

CONTRIBUTIONS OF THE CHEMIST TO THE POTABLE WATER INDUSTRY

By Wm. P. Mason
Professor of Chemistry Rensselaer Polytechnic Institute

Less than a generation ago, the chemist approached the question of "Potable Water" with a confidence born of his ignorance, and he issued his pronouncements after an examination less thorough than that required to determine the fitness of a water for boiler uses.

E. Frankland and J. A. Wanklyn in England, and W. R. Nichols in America recognized that something more was needed than a knowledge of "total solids," "mineral matter" and "loss on ignition" before an opinion could be formulated as to the potability of the sample, and to them are largely due the beginnings of that advance in the technique of water examination which has taken such strides in our day.

It was perhaps to have been expected that, in their enthusiasm over their improved analytical processes, the water chemists should make the blunder, into which the bacteriologists fell at a later day, of demanding more from their recent discoveries than could with reason be asked. Thus we find Wanklyn dogmatizing upon the infallibility of the "albuminoid ammonia" process and insisting upon the reliability of a fixed standard for all waters, which measure should divide the good from the bad with accuracy.

Slowly, however, there crept into the minds of chemists the conviction that general standards could not be maintained, as waters were too various for their application; and therefrom developed the tendency towards that breadth of view in the matter of interpretation of analytical results which has led to a recognition of the great importance of what is now termed the "Sanitary Survey."

Considering that any one of the sundry items reported in an ordinary water analysis, is in itself harmless, and, therefore, is scrutinized only because of the possible bad company it might keep, it was soon admitted that an unusually high reading might be accounted for through some perfectly innocent cause in water from one locality and, therefore, justify a favorable report, while the same data from water derived elsewhere might determine condemnation of the sample.

The dictum is not new but it is as true as when first uttered that "no opinion should be risked as to the quality of a water from an unknown source."

It is even possible to add this further word, that, although we need all the light that chemistry, bacteriology and microscopy can throw upon the question as to the suitability of a water supply, nevertheless if but a single branch of inquiry be available the "Sanitary Survey" is the one to be chosen.

While declining to be bound by the hard and fast "standards of purity" advocated in the past, chemists have nevertheless done faithful work towards the establishment of suitable "comparates" where such records can be of service.

For instance, those chemists who undertook a determination of the "normal chlorine" of Massachusetts and Connecticut, and who gathered the data for plotting the "iso-chlors" of those states, certainly added much towards making an interpretation of analytical results more reliable.

Analytical averages for gound waters are now separated from those of surface supplies; the measure of "hardness" is so defined that the non-chemical laundry-man or boiler-user can easily secure the information he needs; and, further, the public is informed as to how much iron would likely be objected to by the average community.

"Turbidity" and "color" are no longer described in words but are reported in definite "parts per million," as are the other items of the analysis, to the great advantage of the manager of the city filter, whose duty it is to watch the work done by the purification plant for which he is responsible.

The day is passed when a municipal filter is expected to run itself, except during its period of occasional cleaning. A chemist and bacteriologist will now be found continually on duty, ready to detect faulty operation on the part of the plant and prepared to apply those remedies which experience has shown to be proper under the circumstances.

"Pin-point coagulation" and its relation to water temperature is one of the disturbances of a mechanical filter that the chemist in charge must watch, for as the late autumn approaches, and the thermometer reads forty or less, the flocks of aluminum hydroxide decrease in size and tend more and more to pass through the sand bed.

Without a trained man in charge, aluminum compounds are likely to pass the filter at any time, for it is an easy matter to carelessly allow an overdose of alum to reach the filtered water; but the detection of too great an addition of coagulant is one of the simplest jobs the attending chemist has to do and it requires small effort on his part to keep down the alum bill.

When "bleach" is needed, as so often is the case, its strength in "available chlorine" must be determined, not only that the management may know the quality of the goods for which payment is made but also that a proper "dose" may be added to the water. Enough must be turned into the supply to do the work demanded, but an overdose should be avoided lest its disagreeable taste be complained of by the consumers. Who but the chemist in charge is to fix the proper value for the dose of "bleach" and who else can suggest a remedy if the right quantity should accidentally be exceeded?

It would not seem a very complex matter to supply properly purified water to a few people, but when this procedure is to be undertaken upon a large scale, the duties of the chemist in charge of the work become most varied. He has to examine and report not only upon the water product itself but also upon all the odds and ends of supplies and equipments that enter the establishment. Such a chemist must of necessity be a bacteriologist, and it would be of advantage to him should he be an electrician, mechanical engineer, biologist and general sanitarian as well.

So it is seen that the old rivalries between the chemist and the bacteriologist in the field of water supply have been outgrown and extinguished in that fusion of activities which produced the present water purveyor. There is yet much of the chemist in his makeup because there is much that is chemical in the detail of his daily work. Without bacteriology, he admittedly could not go far, because with that branch of his mental equipment he detects the present danger lurking in the water under investigation, but it is to chemistry he must turn in order to inquire as to the future and to estimate the probability of a yet distant danger following upon present safety. No better example of what is meant could be given than to cite a very recent instance falling within the writer's experience.

Two wells, each fifty feet in diameter, were sunk eighteen feet deep in a sandy soil, within a half mile of each other.

They were intended for use "in tandem" upon the same water service. One of these was, by bacteriological examination, shown to be grossly contaminated, a showing which was confirmed by both chemical analysis and the sanitary survey; the water from the other well appeared to be singularly good from the bacteriological standpoint but the chemical analysis indicated very material "past pollution" and the sanitary survey located the cause for such indication. The sandy soil had filtered out and removed all offending organisms but the soluble material which accompanied them had passed on and revealed a threatening danger. Of course, the objection to the water was, not what it contained at the time of observation, but what it would be likely to contain in the future should the protective barriers of nature be overworked or broken down.

Without the chemical side of the investigation no comprehensive report could have been rendered in this case.

And so, in short, chemistry takes its position on the prophetic side of water examination, and it is aided, not supplanted, by the science of the bacteriologist.

The latter's work has to do with showing things as they now exist, while the chemist's field reaches back into the past and throws as well no uncertain light into the future.

Troy, New York

CONTRIBUTIONS OF THE CHEMIST TO THE CELLULOID AND NITROCELLULOSE INDUSTRY

By R. C. Schüpphaus
Consulting Chemist

When we bear in mind that the discovery of nitrocellulose was due to chemical research, we perceive at once that the development of industries based on this discovery must be indissolubly linked with the patient work of the chemist. It need hardly be dwelt upon that the hopes built on the availability of nitrocellulose as a successor to gunpowder were realized only forty years later. Yet the new material quickly found its place in the arts of peace, first as photographic and surgical collodion. The employment of nitrocellulose as the base or an ingredient of explosives, either propelling or shattering agents, is beyond the scope of this article and will not be discussed. However, it must not be forgotten that the work done by chemists in this field, both for war offices and private manufacturers, was of great assistance to the workers in other directions and that the results achieved by this second line of investigators paved the way for the manufacture of gelatinated explosive nitrocellulose compounds, the modern powders and explosives. All the applications of nitrocellulose in the arts are based on the fact that the structure of its various forms may be broken down by the action of suitable solvents. The discoverer of nitrocellulose was already in possession of its colloid solution. The differences between soluble and insoluble varieties (in certain solvents) were quickly recognized, and representatives of four great groups of solvents were known at the very dawn of the nitrocellulose industries, *viz.:*

1—Alcohols : Methyl and ethyl alcohols.
2—Esters : Methyl and ethyl acetates.
3—Ketones : Acetone.
4—Mixed solvents : Ethyl alcohol and ethyl ether.

With these fundamental facts to start from there began a long line of chemical activity. Among the industries developed, the manufacture of pyroxylin plastics occupies the first place, and the other developments, such as the production of photographic films, artificial leather, pyroxylin varnishes and even artificial silk made from collodion may be regarded as offshoots from this branch. The activity of the chemist in this industry is twofold, covering research and control of operations. It was necessary to investigate and select the best raw materials, devise methods for their purification and to solve the problem of the production of a nitrocellulose of even composition on a large scale. The various industries require pyroxylin of different characteristics, such as nitrogen content, solubility in specified solvents and viscosity of such solutions. These conditions were worked out in the factories, and the work done in their laboratories would fill volumes. Needless to say that the influence of proportion of acid to cellulose, the composition of the acid bath, temperature and time factors were known to the chemists in these industries long before the laboratories of scientific institutions took these matters up. Important discoveries concerning the connection between solubility, viscosity and mode of production were made and put to practical use. The methods of analysis of the acids and their mixtures as well as of the nitrocellulose and its finished compounds were brought to the greatest refinement and developed to a state which permitted the quick attainment of results that technical operations call for. The determination of oxalic acid in the nitrating bath, for instance, which the latest literature lays much stress on, has been a routine operation for a long period in well-conducted factories. Other problems sprang from the demand for perfectly transparent materials, requiring special methods of washing and stabilizing the nitrated cellulose. In the designing of the most efficient apparatus for the manufacture of the ever-growing quantities of nitrocellulose the chemist took a prominent part. The urgent call for an economical method of regenerating the weakened acid bath was met by the simple and elegant process of adding fuming sulfuric acid to the fortifying mixture which enables a skilled operator to avoid any accumulation of spent acids with all its drawbacks. The best way of removing the larger part of water from the washed nitrocellulose consists in displacing the water by alcohol. While the problems presented appear at first glance purely physical, yet their solution required the alert coöperation of the chemist. So much for the basic material.

In the industry of pyroxylin plastics the original Spill solvent of 1869, commercial grain alcohol and camphor, still reigns supreme. In the intervening years many expedients have been tried, owing to the fiscal policies of various countries in regard to alcohol, and wood alcohol and fusel oil or its separate constituents have found wide application. The other groups of solvents were advantageously extended by the introduction of the esters of the alcohols of fusel oil and of polyatomic alcohols, of ethers of higher alcohols and phenols, of aromatic nitroderivatives and other compounds. These solvents are, however, of more importance in the allied industries. With the rising price of camphor, which is nearly treble of what it was thirty years ago, the old attempts to produce the material from cheaper products were stimulated, and today large factories exist for its manufacture, thus putting a check on unreasonable advances. The same cause led to the elaboration of methods of recovering camphor from scrap materials that cannot be utilized in other ways. The feverish searching for a camphor substitute has been less successful though large classes of solid solvents of pyroxylin were discovered. A few of them, belonging to the group of acid derivatives of aromatic amins, find a limited application for special purposes. Chemical investigation has led to a revision of the old mixing formulas for the manufacture of pyroxylin plastics, and the old empirical standards have been abandoned. The chemist is continually called upon for advice regarding the application of coloring matters and other materials for obtaining special effects.

The allied industries are based on the same principles. In the manufacture of photographic films, varnishes and artificial silk from pyroxylin flowing solutions are prepared. Artificial silk made from dissolved nitrocellulose and subsequently (preferably) denitrated is being superseded by threads made from cellulose brought into solution by other means.

There is not a factory of pyroxylin compounds of any importance in existence today that has not its busy staff of analytical, managing and research chemists.

175 Pearl Street, New York

CONTRIBUTIONS OF THE CHEMIST TO THE GLASS INDUSTRY

By A. A. Houghton
Vice-President Corning Glass Works

The first experiments dealing with the chemical composition of glass of which we have record were directed toward producing glasses for optical purposes. To give an achromatic image the crown glass lens of a microscope or telescope should have with low refractive index not only the same total dispersion, but also the same partial dispersion in all parts of the spectrum as the flint.

The glasses originally available for optical purposes were made up of only five oxides—silica, potash, soda, lime, and lead oxide—and the crown and flint pairs obtained by means of this limited list of constituents gave a strong secondary chromatic aberration, owing to the different distribution of dispersion in the crown and flint.

Fraunhofer, working with the glassmaker Guinand, by varying the composition of the common glasses, succeeded in materially reducing the chromatic aberration. The glasses were never produced in quantity, however, and there probably was some practical difficulty which prevented their use.

In 1829, the well-known chemist Döbereiner of Jena introduced barium and strontium into glass and probably made other experiments along the same line. A letter to Döbereiner from the poet Goethe, whose interest in optical problems is well known, shows that Goethe made an attempt to establish in Jena a scientific glass laboratory under Döbereiner's instruction.

Harcourt, the English clergyman chemist, in 1834, was the first to experiment systematically on the introduction of new substances into glass; his purpose was to determine the relation between chemical composition and optical properties. He was the inventor of the first experimental furnace for high temperature work, consisting essentially of a small platinum crucible rotating in a hydrogen flame. He discovered that boric oxide and phosphoric oxide will combine with almost any other oxide to form a glass. Harcourt, in a series of experiments extending over 35 years, introduced into glasses in important quantities twenty elements in addition to those already in use. No immediate practical result came from Harcourt's work owing partly to lack of homogeneity of his glasses and partly to the fact that when polished they were quickly tarnished by the moisture of the air.

Otto Schott was the son of a Westphalian window-glass manufacturer. Although his first experiments in glass melting, made while a student of chemistry, were not for optical purposes, yet he early came into contact with Prof. Ernst Abbe who was in serious quest of better glasses for optical instruments. About this time (1880) Schott was planning to undertake on a manufacturing scale the production of new glasses for scientific purposes, but Abbe convinced him that the laboratory method would yield results more quickly. Rather, however, than take up the systematic and slow investigation of all possible combinations of silicates as proposed by Abbe, Schott, guided by his chemist's instinct and his knowledge of the optical properties of the natural minerals, went at once to the substances which appeared to him most likely to furnish glasses of unusual characteristics and submitted to Abbe for examination boric oxide and metaphosphoric acid in glass form. This was little less than a stroke of genius, for to the present day it is boric oxide more than any other one constituent which makes possible the glasses of special properties for use in optical instruments, thermometers, lamp chimneys, laboratory ware, etc.

In January, 1882, a laboratory for glass melting was established at Jena supported by Abbe, Schott, and the Zeiss optical firm. By 1883 the Zeiss works had made up with the new borate and phosphate glasses microscopes in which the disturbing secondary spectrum had entirely disappeared. It is to these microscopes designed by Abbe for glasses made by Schott that modern biology owes its extraordinary development.

In 1884, Schott took a step as a business man which perhaps contributed as largely to the development of the glass industry as anything that he accomplished as a chemist. Together with Abbe and the Zeiss brothers he invested 60,000 Marks in a factory for the melting of the new glasses, which, up to that time, had been made on a small scale only. The Prussian Government, urged by scientific men interested in optics and thermometry, contributed another 60,000 Marks. The enterprise promised little in financial return, for the amount of glass required for optical instruments is from the glass-maker's point of view absurdly small.

After optical glass, the first development in the new factory was a thermometer glass. When a thermometer cools after use above room temperature the mercury reservoir returns only very slowly to its original volume, and at the temperature of melting ice the thread will therefore stand at a lower point on the scale than originally. With ordinary glasses this depression of the zero point after heating to 100° amounts to about 0.7°; after use at higher temperatures the error is much greater. The chemist Weber had found that a potash glass free from soda showed less than the usual depression of the zero point, and Schott proved that either a potash glass or a soda glass gives better results in this respect than a glass containing both alkalis. Schott finally developed glasses which practically eliminated the error. These were the well-known Jena normal glass, 16^{III}, and Jena borosilicate glass, 59^{III}. The 59^{III} has the further advantage of requiring a high temperature for softening, so that with it thermometers can be made reading to 500° C. or higher.

The borosilicate glasses have low coefficients of expansion, and their use for lamp chimneys, especially in lamps with the incandescent gas mantle, has probably been the most profitable commercial application of the new glasses. Here also incidental advantages resulted from the use of the new material, for it was found that the low-expansion glasses could be shaped and perforated more freely than the old, and chimneys of more efficient design have followed.

It is hardly necessary to remind chemists of the revolution in laboratory glassware brought about by Schott's development of a glass practically insoluble in reagents and at the same time capable of use directly over the flame without wire-gauze protection. This was in itself no small achievement.

The manufacture of Schott's compound glass for boiler water gauge tubes is based on the same principle as the process of tempering glass by sudden cooling in hot oil. In both cases the glass is made mechanically strong by the presence of a surface layer under compression. Glass tubing as ordinarily made, without annealing, takes on compression strain on the outer surface and tensile strain on the inner surface. The outer layer cools first and then tends to prevent the normal contraction of the more slowly cooling inner layer. The inner layer is held by the outer in a state of tension, while the outer layer in turn is drawn by the inner into a state of compression. By lining the tube with a glass of lower expansion, which on cooling obviously reaches its normal contraction with less change of volume, Schott not only eliminates the tensile strain and the resulting weakness of the inner surface but actually introduces compression strain caused by the inner surface cooling somewhat more rapidly than the adjacent layers within the wall of the tube. The result is not entirely unlike that produced by shrinking the jacket on a large gun. The compound gauge glasses thus produced excelled all others made at that time in resistance to pressure, to sudden temperature change, and to the solvent action of water and steam.

To Schott we owe also the Uviol glass for transmitting ultraviolet light. This has been of service in therapeutics and in astronomy; the number of stars revealed by the photographic plate is actually increased 50 per cent by use of a telescope-objective of Uviol glass.

Among the properties investigated at Jena in relation to chemical composition are the following:

Specific Heat	Solubility	Specific Gravity
Thermal Conductivity	Hygroscopicity	Tensile Strength
Thermal Expansion	Refraction	Compression Strength
Dielectric Constant	Dispersion	Modulus of Elasticity
Electromagnetic Dispersion		Hardness
Electromagnetic Rotation of Plane of Polarization		
Absorption (Transmission) of Radiation Both Within and Without the Visible Spectrum	Diathermancy Ultraviolet Transmission X-ray Transmission and Fluorescence	

The physical measurements were made in collaboration with the Physics professors of the Jena University and their students. In the glassworks on the chemical side Schott has had the assistance of such men as Herschkowitz, Schaller and Zschimmer, all of whom have contributed to the literature of glassmaking. It is to Zschimmer's work on "The Glass Industry in Jena" that we are indebted for many of the facts here presented.

Other names to be mentioned in connection with glass development are Henrivaux at St. Gobain, famed for plate-glass; Bontemps, maker of optical glass at Choisey-le-Roi and later at Birmingham with Chance; the Guinands, the eldest of whom originated the stirring process for optical glass; Feil, Mantois, Verneuil, Benrath, Powell, Chance, Harris, Siemens; and to the list might be added others equally deserving.

America's contributions to the development of the glass industry, chiefly in methods of working and handling the molten glass, are epoch-making in character; along more strictly chemical lines creditable work has been done, as instanced by the Tiffany or Aurene glass, the selenium red, and others. Aside from optical glass, on which a beginning is being made, the glasses produced in this country probably are fully equal in quality and variety to those produced abroad; and in some respects America is forging ahead.

Corning, New York

CONTRIBUTIONS OF THE CHEMIST TO THE PULP AND PAPER INDUSTRY

By F. L. Moore
President American Paper and Pulp Association

The manufacture of pulp and paper is an industry based largely on chemical reactions and processes and as such has been largely dependent upon the efforts of chemists for its maintenance and advancement. Chemists of former days are responsible for inventions to which paper making literally owes its existence in its present form, and our modern chemists are essential factors in the every-day operation of this industry. It is not too much to say that the development of modern paper making and the enormous extensions of the use of paper in recent times have been due for the most part to the introduction of the three chemical processes by which wood fiber has been made available as a general substitute for rags.

The sulfite process, by which wood is reduced to paper pulp by digestion in acid bisulfite solutions, was invented by a Philadelphia chemist, B. C. Tilghman, in 1867. Tilghman was also the inventor of the sandblast and of the important autoclave process for the manufacture of glycerin. Although his attempts to manufacture sulfite fiber upon a commercial scale failed and were abandoned because of the many serious technical difficulties encountered, his patents nevertheless disclosed a remarkably clear and comprehensive understanding of the principles involved. The process was later taken up in Sweden by Ekman and in Germany by Mitscherlich, both of whom were chemists, and by other inventors in England and elsewhere, by whom it was developed along somewhat divergent lines. It returned to the United States in 1883 when the mill of the Richmond Paper Company was built at Rumford, Rhode Island, to operate under the Ekman modification of the process, with a nominal capacity of 10 tons per day. Arthur D. Little, who served for many years as official chemist of the American Paper and Pulp Association, began his professional work as chemist to this plant. From this modest beginning, the sulfite industry of the United States has developed at present to a daily production of over 5,000 tons, and the process has revolutionized many departments of paper manufacture. Needless to say its efficient operation requires constant chemical supervision and control.

Another important chemical wood process, the soda process, by which the wood is reduced to pulp by digestion in a strong solution of caustic soda, became possible only after the discoveries and engineering triumphs of a long series of chemists from Le Blanc down through Muspratt, Weldon and Tennant, had supplied the world with cheap caustic and carbonated alkali.

The soda process itself as applied to the manufacture of wood pulp is, like the sulfite process, of American origin, having been invented by Watt and Burgess, in 1853, and developed at Manayunk, near Philadelphia. At first, and for many years, the process was operated with no attempt at recovery of the soda liquors. The process has been able to hold its own only because of the development, largely by chemists, of the processes of soda recovery. Similarly, in case of the sulfite process, many chemists have attacked the far more difficult problem of utilizing the waste sulfite liquors, but thus far only with moderate success. It is, nevertheless, to chemists that we must look for the solution of this important problem.

The sulfate process for chemical wood pulp, an interesting modification of the soda process, was developed by the chemist Dahl at Danzig about 1883. It has become of great industrial importance during the last few years through its application to the manufacture of the now well known Kraft wrapping paper, the introduction of which from Sweden has already exercised a profound influence upon the whole wrapping paper industry.

The great names of Le Blanc, Weldon, Solvay and Mond stand for the highest type of the chemical engineer, and to them and the long line of their associates and successors the paper trade, like many other industries, is indebted for the cheap alkali and cheap bleaching powder, without which it could hardly exist today. It is only necessary to contrast the old methods of treating rags by retting and grass bleaching, with the modern methods of pressure cooking and rapid bleaching, to realize how many of the foundation stones of paper making have been set in place by chemists.

A further step in advance is the production of electrolytic bleach and alkali which has become a matter of routine in many paper mills as the result of the discoveries of Watt in 1851, and the later work of chemists like Le Sueur, Hargraves, Castner, Townsend and many others.

Among the less fundamental, but nevertheless highly important advances in the art of paper making, which are directly attributable to the chemist, is the introduction of coal tar colors. Practically all of the colors now employed in paper making are the products of the chemical laboratory, the work of an army of German chemists having supplied us with the whole wonderful range of coal tar colors, many of which are more permanent than the natural dye-stuffs which they displace.

To chemists also we are indebted for the discovery of the useful properties of rosin in rendering paper resistant to ink and water and for the modern methods of rosin size production, for processes for producing casein for paper coating and for rendering it insoluble by the action of formaldehyde, for the discovery of soluble starch so largely used for top sizing, for processes of water purification and those for the manufacture of alum, especially of the high-grade alum, the cheap production of which has been made possible by the Bayer process for the manufacture of pure alumina.

Enough has been said to indicate the vastly important service which the chemist has rendered in the development of the pulp and paper industry. The chemist of today is no less vital to the industry's operation and advancement. Under the stress of modern competition, pulp and paper manufacturers are forced to turn to the chemist with constantly increasing frequency for the testing of supplies, for the control of processes, many of which are essentially chemical in nature, and for the elimination of wastes. The testing of paper, which yearly assumes increasing importance, is entirely in the hands of the chemist, and the chemist is in large part responsible for the startling expansion in the use of paper which has taken place in the last two decades.

CONTRIBUTIONS OF THE CHEMIST TO THE INDUSTRIAL DEVELOPMENT OF THE UNITED STATES—A RECORD OF ACHIEVEMENT[1]

By Bernhard C. Hesse

Since the outbreak of the European War, the American public has been led, adroitly or otherwise, to believe that industrial chemistry, that is, the industrial activity of the chemist, is limited to coal-tar dyes and that nothing should be regarded as industrial chemistry that does not deal with the manufacture of these dyes. Nothing could be further from the truth.

While it is true that the manufacture of coal-tar dyes forms an important branch of industrial chemistry, or of chemical industry, whichever you will, it by no means forms the whole of it or even a preponderating part of it.

From the economic point of view, economic effect and economic result is the measure to apply in determining economic importance and not the intellectual or scientific labor involved in the creation of that result.

From a strictly economic point of view coal-tar dyes can hardly be said to be vital or essential and by that I mean, that we can get along without them and not suffer great hardship, personal or otherwise; anything of less need than that can hardly be called an economic necessity.

THE CHEMIST AND HIS WORK

The American public has seemingly given too little consideration to those industries of this country that make use of chemical knowledge and experience in the manufacture or utilization of products and yet these are the ones that compose chemical industry or industrial chemistry.

For the present, permit me to give in a few words the substance of the impressive series of papers presented at the meetings of this forenoon and this afternoon, and, as this presentation is being made, please have in mind the question as to whether you would prefer to have the United States able to produce all of its requirements of coal-tar dyes and *not* able to produce any of the various things which I am about to mention.

According to this symposium there are at least nineteen American industries in which the chemist has been of great help, either in founding the industry, in developing it, or in refining the methods of control or of manufacture, thus rendering profit more certain, costs less high and output uniform in standard amount and quality.

The substitution of accurate, dependable and non-failing methods of operation for "rule-of-thumb" and "helter-skelter" methods must appeal to every manufacturer as a decided advancement and a valuable contribution.

NINETEEN AMERICAN CHEMICAL INDUSTRIES

In presenting to you these various contributions of the chemist, I by no means wish to be understood as in any wise minimizing or reducing the contributions made to the final result by others, such as merchants, bankers, engineers, bacteriologists, electricians, power-men and the like; all that I wish to emphasize is that the chemist *did* make a contribution, and to that extent he is entitled to credit and acknowledgment.

The chemist has made the WINE INDUSTRY reasonably independent of climatic conditions; he has enabled it to produce substantially the same wine, year in and year out, no matter what the weather; he has reduced the spoilage from 25 per cent to 0.46 per cent of the total; he has increased the shipping radius of the goods and has made preservatives unnecessary.

In the COPPER INDUSTRY he has learned and has taught how to make operations so constant and so continuous that in the manufacture of blister copper valuations are less than $1.00 apart on every $10,000 worth of product and in refined copper the valuations of the product do not differ by more than $1.00 in every $50,000 worth of product. The quality of output is maintained constant within microscopic differences.

Without the chemist the CORN PRODUCTS INDUSTRY would never have arisen and in 1914 this industry consumed as much corn as was grown in that year by the nine states of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey and Delaware combined; this amount is equal to the entire production of the State of North Carolina and about 80 per cent of the production of each of the States of Georgia, Michigan and Wisconsin; the chemist has produced over 100 useful commercial products from corn, which, without him, would never have been produced.

In the ASPHALT INDUSTRY the chemist has taught how to lay a road surface that will always be good, and he has learned and taught how to construct a suitable road surface for different conditions of service.

In the COTTONSEED OIL INDUSTRY, the chemist standardized methods of production, reduced losses, increased yields, made new use of wastes and by-products and has added somewhere between $10 and $12 to the value of each bale of cotton grown.

In the CEMENT INDUSTRY, the chemist has ascertained new ingredients, has utilized theretofore waste products for this purpose, has reduced the waste heaps of many industries and made them his starting material; he has standardized methods of manufacture. introduced methods of chemical control and has insured constancy and permanency of quality and quantity of output.

In the SUGAR INDUSTRY, the chemist has been active for so long a time that "the memory of man runneth not to the contrary." The sugar industry without the chemist is unthinkable.

The WELSBACH MANTLE is distinctly a chemist's invention and its successful and economical manufacture depends largely upon chemical methods. It would be difficult to give a just estimate of the economic effect of this device upon illumination, so great and valuable is it.

In the TEXTILE INDUSTRY, he has substituted uniform, rational, well thought-out and simple methods of treatment of all the various textile fabrics and fibers where mystery, empiricism, "rule-of-thumb" and their accompanying uncertainties reigned.

In the FERTILIZER INDUSTRY, it was the chemist who learned and who taught how to make our immense beds of phosphate rock useful and serviceable to man in the enrichment of the soil; he has taught how to make waste products of other industries useful and available for fertilization and he has taught how to make the gas works contribute to the fertility of the soil.

In the SODA INDUSTRY, the chemist can successfully claim that he founded it, developed it, and brought it to its present state of perfection and utility, but not without the help of other technical men; the fundamental ideas were and are chemical.

In the LEATHER INDUSTRY, the chemist has given us all of the modern methods of mineral tanning and without them the modern leather industry is unthinkable. In the case of vegetable-tanned leather he has also stepped in, standardized the quality of incoming material and of outgoing product.

In the FLOUR INDUSTRY the chemist has learned and taught how to select the proper grain for specific purposes, to standardize the product and how to make flour available for certain specific culinary and food purposes.

In the BREWING INDUSTRY, the chemist has standardized the methods of determining the quality of incoming material and of

[1] Public Address at the 50th Meeting of the American Chemical Society, New Orleans, March 31 to April 3, 1915.

outgoing products, and has assisted in the development of a product of a quality far beyond that obtaining prior to his entry into that industry.

In the PRESERVATION OF FOODS, the chemist made the fundamental discoveries; up to twenty years ago, however, he took little or no part in the commercial operations, but now is almost indispensable to commercial success.

In the WATER SUPPLY OF CITIES, the chemist has put certainty in the place of uncertainty; he has learned and has shown how, by chemical methods of treatment and control, raw water of varying quality can be made to yield potable water of substantially uniform composition and quality.

The CELLULOID INDUSTRY, and the NITRO-CELLULOSE INDUSTRY owe their very existence and much of their development to the chemist.

In the GLASS INDUSTRY the chemist has learned and taught how to prepare glasses suitable for the widest ranges of uses and to control the quality and quantity of the output.

In the PULP AND PAPER INDUSTRY the chemist made the fundamental observations, inventions and operations and today he is in control of all the operations of the plant itself; to the chemist also is due the cheap production of many of the materials entering into this industry as well as the increased and expanding market for the product itself.

THE STATISTICAL POSITION

For the census year of 1909 the wage-earners and the value of manufactured products and the value added by manufacture in twelve of these industries and in the manufacture of chemicals is given in Table I*a*.

AMERICAN INDUSTRIES *vs.* COAL-TAR DYES

A most liberal estimate of the market value of the world's entire production of coal-tar dyes places it under $100,000,000;

TABLE I*a*	Wage-earners	Product value	Value added by manufacture
Wine	1,911	$ 13,120,846	$ 6,495,313
Copper	15,628	378,805,974	45,274,336
Fertilizer	18,310	103,960,213	34,438,293
Textiles	44,046	83,556,432	48,295,131
Canned and preserved foods	59,968	157,101,201	55,278,142
Cotton-seed oil	17,071	147,867,894	28,034,419
Cement	26,775	63,205,455	33,861,664
Sugar	20,730	327,371,780	52,523,806
Brewing	54,579	374,730,096	278,134,460
Leather	62,202	327,874,187	79,595,254
Glass	68,911	92,095,203	59,975,704
Paper and wood pulp	75,978	267,656,964	102,214,623
Chemicals (strictly)	23,714	117,688,887	53,567,351
TOTALS	529,823	$2,455,035,132	$897,688,496
TABLE I*b*			
Iron and steel	278,505	$1,377,151,817	$399,013,072
Petroleum refining	13,929	236,997,659	37,724,257
Lead smelting and refining	7,424	167,405,650	15,442,628
Illuminating and heating gas	37,215	166,814,371	114,386,257
Confectionery	44,638	134,795,913	53,645,140
Paint and varnish	14,240	124,889,422	45,873,867
Soap	12,999	111,357,777	39,178,359
Carpets and rugs	33,307	71,188,152	31,625,148
Explosives	6,274	40,139,061	17,328,113
Zinc smelting and refining	6,655	34,205,894	8,975,893
Turpentine and rosin	39,511	25,295,017	20,384,174
Oil cloth and linoleum	5,201	23,339,022	7,788,921
Chocolate and cocoa	2,826	22,390,222	8,867,162
Baking powder and yeast	2,155	20,774,588	11,436,603
Dyestuffs and extracts	2,397	15,954,574	6,270,923
Blacking, cleansing and polishing preparations	2,417	14,679,120	7,716,728
Wood distillation other than turpentine	2,721	9,736,998	3,861,147
Oleomargarine	606	8,147,629	1,650,997
TOTALS	513,020	$2,605,262,886	$829,052,389
TOTAL FOR 31 CHEMICAL INDUSTRIES	1,042,843	$5,060,298,015	$1,726,740,885
TOTAL FOR ALL INDUSTRIES	6,615,046	$20,672,051,870	$8,529,260,992

the entire consumption in the United States is less than $15,000,000, duty included, and this amounts to about 15 cents per person per year.

Now, which would you rather have, these thirteen industries with their $2,500,000,000 worth of manufactured product or the coal-tar dye industry with its $100,000,000 of product? The number of persons employed in these above thirteen industries is in excess of 500,000; the entire world's supply of coal-tar dyes is made by fewer than 40,000 people. Which would you rather have?

These thirteen industries employ 8 per cent of all wage-earners in manufacturing enterprises in the United States, produce 12 per cent of the total value of manufactured product and 10.5 per cent of the total value added by manufacture. In other words, the chemist engaged in these thirteen pursuits plays an important, if not indispensable part in the lives of 8 per cent of our wage-earners and affects 12 per cent of our manufacture values and 10.5 per cent of our values added by manufacture. But the total number of chemists makes up only about 0.01 per cent of the population of the United States.

NO NATION CAN DO EVERYTHING ITSELF

Of course, it may be said that having made all these other things, there is no excuse why the American should not make coal-tar dyes in addition. Perhaps so; but nations, like individuals, cannot each have or do everything. If each nation could do everything equally as well as every other nation, there would be no occasion whatever for international business. As this world is constituted, each nation does that which it can do the best and trades off the product for what some other nation can do better than it, and both sides are satisfied and make a profit; this is the same as the relationship between individuals. The shoemaker can make shoes better than he can bake bread; he makes shoes and exchanges part of his income with the baker for bread which the baker has made.

If American chemists can operate these industries better than or as good as other nations, it is no real ground for criticism that they cannot do everything better than any other nation, no more than the shoemaker is to be criticized because he cannot make as good a suit of clothes as can the tailor. If you want the shoemaker to be able to make a suit of clothes as well as the tailor you must provide him with the opportunity to learn how to tailor and take care of him while he is learning, and no doubt his suit of clothes will cost him more than it would cost an established tailor to turn out the same kind of a suit of clothes, and you must again help your shoemaker while he is trying to market his suit of clothes against the established tailor.

EIGHTEEN ADDITIONAL AMERICAN CHEMICAL INDUSTRIES

The above nineteen American industries referred to by no means comprise all the American industries in which the chemist can be of help and of assistance. Many more are open.

A search through the census for 1909 discloses the eighteen additional industries listed in Table I*b* which make use of chemists in the control of their operations.

In these eighteen additional industries the chemist affects 8 per cent of our wage-earners, 12.6 per cent of our manufacture values and 9.7 per cent of our values added by manufacture. For these thirty-one industries, then, the 0.01 per cent of chemists of our population directly affect 16 per cent of our wage-earners, 24.6 per cent of our manufacture values and 20.2 per cent of our values added by manufacture.

This, therefore, is a measure of the influence of the chemist upon the industrial development of the United States; however gratifying this result is, it is nevertheless true that many other industries could employ chemical control to great advantage, if they only would, and many establishments under the above cited industries could, if they would, make use of chemical control. There is plenty of work left for the chemist to do in these industries to keep him fully and profitably engaged. This being so, why should he not continue to direct his energies to improving those things that he can already do, rather than attempt new and exotic things which others can do better than he?

THE FOREIGN BUSINESS

So much for our internal relations. How about our international relations? To answer this question I will use the official classification of the German Government as to what constitutes products of and for chemical industry and also the same Government's corresponding figures for 1913.

No two countries, speaking through their statistical departments, have the same working definition of chemical industry. None of the official classifications is as comprehensive as is the official German classification. So far as the exchange of products and commodities involved in chemical pursuits is concerned, the German classification shows a total of 442 items of which 229 are involved in international trade between Germany and the United States. According to these figures and this classification, the United States imported from Germany in 1913, $60,860,880, and exported to Germany $156,036,090, or a total business of $216,896,970, with a balance in favor of the United States of $95,175,210. I have selected from this 1913 list of items of business between Germany and this country those whose gross is $400,000 per annum or over (Table II).

It is interesting to note that we sell Germany more lard than Germany sells us of potash and aniline and other coal-tar dyes put together; that we sell Germany half again as much refined petroleum as it sells us aniline and other coal-tar dyes; that we sell Germany practically the same amount of pig and scrap lead as Germany sells us of alizarin and anthracene dyes; that we sell Germany almost as much paraffine as Germany sells us of indigo; and so on through the list.

Table II—U. S. Chemical Trade with Germany (1913)

U. S. imports from Germany	Value in U. S. money	U. S. exports to Germany
	$75,000,000	1 Copper
	26,700,000	2 Lard
1 Potash salts	18,819,000	
	12,690,000	3 Refined petroleum
2 Aniline and other coal-tar dyes	7,290,000	
	4,970,000	4 Phosphate rock
	4,880,000	5 Oleomargarine
	4,585,000	6 Turpentine rosin
	4,460,000	7 Mineral lubricants
	3,840,000	8 Spirits turpentine
3 Caoutchouc	2,582,000	
	2,220,000	9 Crude benzine
	2,171,000	10 Beef tallow (prime)
	1,744,000	11 Nickel and nickel coin
4 Straw, esparto and other fibers; paper stock	1,649,000	
	1,550,000	12 Cotton-seed oil
5 Alizarin and anthracene dyes	1,463,000	
	1,421,000	13 Pig lead and scrap
6 Indigo	1,319,000	
	1,231,000	14 Crude and hard paraffin
	1,162,000	15 Acetate of lime
7 Platinum and allied metals	1,120,000	
8 Hops	952,000	
9 Miscellaneous volatile oils	941,000	
	903,000	16 Tin and tin scrap
10 Tin and tin scrap	900,000	
11 Potassium and sodium cyanide	845,000	
12 Chrome, tungsten, etc.	784,000	
13 Superphosphates	766,000	
	724,000	17 Crude wood alcohol
14 Beet sugar, refined	716,000	
	695,000	18 Carbides
	673,000	19 Miscellaneous volatile oils
15 Alkaloids exc. quinine	672,000	
16 Toilet and tooth powders	658,000	
	656,000	20 Heavy benzine and patent naphtha
17 Lime-nitrogen, etc.	635,000	
18 Potash carbonate	632,000	
	617,000	21 Lubricants of fats and oils
	579,000	22 Beef and mutton tallow
19 Ferro-Al, Cr, Mn and Ni	567,000	
20 Potassium magnesium sulfate	509,000	
21 Gold ores	506,000	
	506,000	23 Copper alloys
22 Beet sugar, raw	492,000	
23 Aniline oil and salt	476,000	
24 Bronze and metal colors	473,000	
25 Glue	471,000	
26 Aluminum plates and metal	454,000	
27 Quinine and its salts	436,000	
	422,000	24 Portland cement
28 Terpineol and allied synthetics	409,000	
29 Gelatin	403,000	

RELATIVE QUALITIES OF IMPORTS AND EXPORTS

Of course, it will be contended that the things that we sell Germany are, from a chemical point of view, less refined, *i. e.*, involve less hard chemical intellectual work than do our imports from Germany. But, is most of the potash, which is practically mined from the ground in Germany, any more of a refined product than the phosphate rock we sell them? Does it not involve quite as much chemical ingenuity to produce good illuminating oil from petroleum as it does to produce many of the coal-tar dyes? There is no question that the general position above outlined is correct, namely, that our products, as a whole, are less refined than those that we get, as a whole, from Germany, but is that not true practically throughout our entire export and import business? Are not the textiles we export of a lower grade than those we import? Are not our leather products less refined than those we buy? And so on down the list. That being so, why pick out the chemist as a special mark for criticism when he is at least up to the average of his surroundings?

In 1913 the total foreign business of the United States amounted to $4,277,348,909, and the excess of exports of all kinds over imports of all kinds amounted to $691,271,949.

The trade in chemicals and products of and for chemical industry between the United States and Germany in 1913 furnished 5 per cent of that total of international business and provided 13.8 per cent of the balance of trade.

THE INFLUENCE OF THE CHEMIST

The symposium of papers presented today constitutes a record of proud achievement, of solid accomplishment in nineteen different branches of American industrial activity, to which advance the application of chemical knowledge, chemical principles, and chemical experience by American chemists, has contributed a noble share and an effective part. It is perhaps true that much of that progress would have come without the American chemist, but it is equally true that under those conditions the advance would have been much slower and also much of what has been accomplished would never have happened at all without the faithful, enthusiastic and alert coöperation of the American chemists on the job. With such a record, the American chemist can hold up his head with pride and self-confidence, firm in the belief, and warranted in his conviction that he has done a man's work, in a man's way, that he has not been an idler, nor a sloth, nor a drone, but that he has been one of the busiest of busy workers, with a keen eye and an alert intellect, always searching for an opportunity for the betterment of his industry, and for improvement of the conditions of his fellow man.

GERMAN SUPREMACY

That the chemist has not done more is by no means due to any unwillingness. It is due in the largest part to the apathetic attitude of those in charge of the management of many of our industrial enterprises requiring chemical knowledge in their exploitation. Many of these men in responsible positions do not have a chemical education even along the lines in which they are financially active. In those cases chemical novelties and chemical problems are not passed upon, on their merits, by chemists or by men with a chemical point of view, but by merchants, by lawyers and by bankers, men who, by their very training, are not capable of taking the chemist's point of view, of having the chemist's sense of proportion, and are unwilling to take a chemist's chance in a chemist's way. Therein lies, perhaps more than in any other one thing, the reason for Germany's supremacy in most of the branches of chemical industry. That also is the reason for the success of a great many of our own huge transportation, electrical and chemical enterprises. The business is run by men who know it from the technical point of view. Railroads are run by men who know the railroads from the operating and construction point of view; electrical enterprises by men who know the business from the electrical engineer's point of view, and they make their enterprises take their business chances in a transportation way, and in an electrical way. Practically all of our chemical enterprises that have been managed in the same manner have also been successful, but there is still great room for improvement, and just as soon as that improvement is accomplished, just so soon, and no sooner, will there be less and less talk about the incompetency of the American chemist. German chemical enterprises are run and managed by chemists.

Some years ago I was thrown in company with a very successful meat packer, and a very successful metallurgist; the packer asked me when chemists would make glycerin synthetically and make it cheap as the price of glycerin was getting to be altogether too high; the metallurgist asked me, rather impatiently, what elements make up glycerin; somewhat dazed, I replied, "Carbon, hydrogen and oxygen." Thereupon the metallurgist said to the packer, "Why, carbon is coal, hydrogen and oxygen are water, both are plentiful and cheap; I do not see why these chemists cannot mix coal and water and produce glycerin." I felt that my life was altogether too short to attempt to educate those two very successful men to a proper appreciation of the difficulties of converting coal and water into glycerin. This metallurgist's answer to the packer might with equal truth have referred to such dissimilar things as wood alcohol, grain alcohol, vinegar, olive oil, castor oil, whale oil, starch, camphor, cane sugar, beet sugar, grape sugar, carbolic acid, alizarin, and host upon host of similarly different things. I do not know whether that packer, when he got home, told his chemist to take a hunk of coal and drop it into a bucket of water, and make glycerin. I hope for the chemist's sake, that he did not give him that task.

THE RESPONSIBILITY OF MANAGERS

If there is such a misconception of the chemistry underlying their own products of manufacture on the part of many of our manufacturers, as this meat packer displayed, and if the general chemical viewpoint of the managers of many of our chemical industries is as confused and unfounded as was the view of this metallurgist, then it is no wonder that American chemical enterprises are behind some other countries; the real wonder is that we have any chemical industry at all. Nor is there any dearth in this country of properly trained chemists. There are almost ten thousand of them now in the United States, and they are being turned out by our technical and other schools with great regularity and with increasing volume every year. The fault is not with the American chemist, nor with his ability, nor his willingness; the fault lies principally and almost wholly with those in charge of many of our industrial enterprises, who fail absolutely in a chemical understanding of their own products and are devoid of any sympathetic contact with chemistry and with chemical points of view and therefore are incapable of, and unable to appreciate the value of chemical work or to have a wholesome understanding of the snares, the pit-falls, and the tedium of chemical research.

CHEMISTS IN MANAGERIAL POSITIONS

This plea for the wider introduction of chemists in positions of managerial responsibility is, however, not to be interpreted into a statement that any kind of a chemist can do any kind of a chemical job. Just because a man can swing a scythe and cut wheat rapidly is no reason why he should be entrusted with the job of giving a man a shave; therefore, if you have a cotton oil problem, do not give it to a man whose specialty and training is in iron and steel only. The non-chemical managers of chemical enterprises will have their hands full picking out the right chemist for the right job and training promising chemical material for managerial positions. To do this successfully is quite an undertaking and will not be accomplished without many trials and many failures. Why should there not be failures? Not every man who is sent out on the road makes a successful traveling salesman, nor is every man put in as a superintendent a success as a superintendent.

In selecting your chemist for a responsible position, you must look out that you do not get a square peg for a round hole, just as you would when engaging a man for any other position, but the trouble seems to be with many of those who have engaged chemists, that they have not appreciated that there are chemists and chemists; they seem to have some sort of an idea that there is a magic about what a chemist does. Now, there is no magic at all. It is all plain, hard work, that calls for a lot of intellectual effort, and above all, the application of common sense, which as every one knows, is a very rare article.

THE RESPONSIBILITY OF THE PUBLIC

With this record of solid achievement placed before you today, together with what I have just said, I hope that the conviction will finally break through, and will penetrate the public mind as well as the minds of those in charge of many of our industrial establishments, that if the American chemist is not doing as much as the public expect him to do, it is because the public through its industrial enterprises has deliberately declined to give him a chance. With this wonderful record of fruitful endeavor is the American chemist to have his chance? The answer to that question is largely in the hands of the American public.

However, the public will have to acquire in some dependable way an appreciation of what the chemist's work stands for and really is. There are numerous difficulties in the way. By its very nature, the work of the chemist is more or less concealed from public inspection. If you have a particularly well tanned piece of leather, the lay-person thinks no further than that it is a pretty good job, and is utterly unable to appreciate the large amount of work that has been necessary to produce or to create the way of making that particularly good piece of leather. There is nothing so conspicuous about the chemist's work as there is, for example, about the bridge builder's work, or about the work of a man who erects a skyscraper. The chemist's work, as a whole, does not fill the eye nor appeal to the imagination; and not filling the eye, and not appealing to the imagination there is really no practical method of valuation easily accessible to the ordinary individual; not only is the ordinary individual incapable of such a valuation, but even men high in industrial pursuits have not that particular intellectual vision which permits them to appreciate the real significance behind any given chemical product. The only exception hereto seems to be coal-tar dyes.

The reason for this exception is not hard to find. Could anything appeal more to the imagination than the conversion of such a disgusting, sickly mess as coal tar into brilliant colors that rival and excel every tint and shade in nature?

THE RESPONSIBILITY OF THE CHEMIST

However, the chemist must not attempt to absolve himself from all responsibility for the prevailing lack of appreciation or skepticism among capitalists and bankers of the value of chemical work in industrial operations. While competent chemists and chemical engineers by their very effective work have wrung from reluctant financial men proper acknowledgment of the value of chemical examination, control and management of enterprises requiring such, yet the work has not gone far enough, and it is not at all unusual for financial men to support with might and main enterprises which any qualified chemist or chemical engineer could and probably did tell them were foredoomed; also it must not be forgotten that qualified chemists and chemical engineers, like other professional advisers, have gone astray in their calculations and have supported enterprises which ultimately failed. The mining, electrical and railroad engineers finally succeeded in obtaining their present influential position among the industrial councils of this country and with the brilliant success of the chemical engineers of Germany in the same direction it is not too much to hope that ultimately the American chemist and chemical engineer will come into his own. When he does, there will be far fewer exploitations than heretofore of the wild and fantastic schemes of chemical enterprise now so easily financed by the gullible portion of our investing public and fewer and fewer failures of chemical enterprises undertaken in good faith and serious mood.

Therefore, let every chemist in advising on chemical operations prominently bear in mind that failure to give correct advice not only reacts upon him but upon each and every member of the chemical profession and merely helps to postpone the day when the chemist will come into his proper position among the makers of the nation.

CONGRESS AND CHEMICAL INDUSTRY

Like every other industry, all the branches of chemical industry are dependent for their ultimate success upon economic conditions. They must be able to sell at a price greater than their costs. It is not enough to have the material, the men, and the "know how;" you must have the market as well. However, the attitude of consumers of chemicals in this country has habitually been opposed to the creation in this country of conditions favorable to the manufacture of chemicals.

The following quotation from an address in 1910, by Dr. W. H. Nichols,[1] presents this aspect of the problem completely.

"If a comparison were made between the chemical industry of this country and that of other countries, it would be found that the industry in this country in most respects is fully on a par with that of any other country, and in some respects is well in the lead. It is a public notion that our industry is coddled by the tariff, and is thereby based upon a somewhat insecure foundation. Like many other public notions, this is not true. It will be seen by casual examination of the imports that there are a number of chemicals which are not made in this country at all, and a number of others which are made only to a moderate extent. This is not due as much to lack of enterprise of the chemical manufacturers as the fact that the tariff is distinctly unfavorable to the manufacture of many chemicals which are produced in Europe on a large scale and whose manufacturers use this country as a 'dumping ground.' In our tariff all chemicals, unfortunately, are enumerated in Schedule 'A.' It has been the history of several revisions of the tariff that these revisions have been approached with a firm intention on the part of our legislators to lower the tariff, and they have begun on Schedule 'A' with a great deal of enthusiasm. The rates of duty of this Schedule have been steadily reduced, and many articles placed upon the free list before the log-rolling, which is popularly supposed to form such an important part of all tariff inquiry, has begun to get in its work; hence the chemical industry has met with constantly lower tariff rates, while the materials which it has to use have often been left in a position unfavorable to chemical manufacturers. In the interest of fair play, it is to be hoped that when the tariff shall again be revised our legislators will begin at the other end of that document.

"I think it may be stated safely that the chemical manufacturers of this country do not ask and have not asked any favors of the people which would result in any way in a fictitious advance in the values of their output. It is also fair to state that the chemical manufacturers of this country, while entirely friendly to one another, are in no way connected by agreements or 'pools.' While there may be exceptions to this of which I am not aware, I think this can be put down as a general statement and I am sure it will be believed by all consumers of chemicals who come in contact with the active salesmen of the numerous companies."

It is, therefore, only fair to say that the American chemist and chemical manufacturer has throughout made the most of his opportunities, has made his fair contribution to the country's need and growth and has taken a fair and proper share in the internal and international business of the United States. The people of the United States, speaking through Congress, have repeatedly told the American chemist and the American chemical manufacturer "so far and no farther will we help you." The chemist and manufacturer have done all that can be accomplished under those circumstances; if they could not attract capital to all the enterprises they desired to found it was for the reason that capital could be more profitably employed otherwise and money has the stubborn habit of going where it can obtain the biggest return—long waits and uncertain results have no attractions for it.

[1] *J. Soc. Chem. Ind.*, **29** (1910), 1443.

CONGRESS HOSTILE TO AMERICAN DYE INDUSTRY

The law makers of the United States knew that coal-tar dyes were made almost wholly in Germany; they knew that those dyes were essential to the ordinary growth and conduct of enterprises in this country, not themselves chemical enterprises but which produced large values of goods annually and employed many people; they knew that attempts had been made for over thirty years to produce those dyes in this country and they knew that they had persistently and deliberately declined to bring about economic conditions which those who were in position to know told them were essential to the establishment of an independent coal-tar industry in this country; they knew that whatever coal-tar dyes were produced in the United States were produced merely by assembling dye-parts which they knew were imported almost wholly from Germany and which they knew could not be profitably made in the United States; finally they knew that if for any reason whatever these dyes could not be obtained from Germany the production of large values of goods and the employment of many people in this country would be interfered with, and very likely seriously interfered with.

THE EFFECT OF THE EUROPEAN WAR

However, hardly had the European war broken out than our daily press, well knowing what our law makers had deliberately and knowingly done, covered the American chemist and the American chemical manufacturer with an avalanche of harsh and unjust criticism for not doing that which our law makers knowingly and persistently had made impossible.

CRITICISM BY THE PRESS

The burden of these criticisms is that American chemists should make those dyes because they are vital and essential to, for example, the textile industries. But the American chemist has persistently said that he cannot afford to make those dyes at prices at which they can be laid down in this country by foreign, particularly German, makers and he therefore does not make them.

The dye users are not prohibited from entering into, or taking part in the manufacture of dyes; they have the same privilege as others of investing their own or other people's money in that business, and if, as they say, these dyes are so essential to their commercial life, any loss sustained by them in the manufacture of dyestuffs could legitimately be regarded as an insurance premium towards continued and uninterrupted business and operation. If that sum be too great to be looked upon as an insurance premium by those supposed to be vitally interested in the having of coal-tar dyes, it certainly is too great a sum for the manufacturer of chemicals to lose or to transfer from an otherwise profitable business into something that is of no real profit or importance to him, from a business point of view.

In an article headed "Dyestuffs Discussion Is Growing Acrimonious," the *Journal of Commerce* of January 29, 1915, says, "* * * * little credence is given to statements that emanate from men with German patronymics." In order to forestall any criticism, I will say that my first name, my middle name and my last name are all and each German and I am of German extraction. At the time I was born in Michigan, my father was a naturalized citizen of the United States; my mother was a Michigan-born woman. I received all my scholastic education in the United States—five years at the University of Michigan and three years at the University of Chicago. From the latter I went directly into the employ of the largest coal-tar dye factory in the world, at its German plant, and remained in its employ for nine years and five months, traveling between New York and the plant as occasion required; for the last nine years and three months I have had my office in New York, and while I have there done some work for German houses, the total income received from them in any form, direct or indirect, during that entire period does not amount to half the salary of a rather inferior office boy. I am sure that this will relieve me of any suspicion of being a German spy or of being in the pay of German interests. I am as American as they make them.

Broadly considered, the criticisms of the press may be grouped as follows:

I—The present shortage of dyes and inaccessibility of German producers to the American market offers an unusual opportunity for the manufacture of coal-tar dyes in this country.

II—The chemical manufacturers of this country should make those coal-tar dyes.

NO SHORTAGE OF DYES

With regard to the first of these it is very pertinent to ask: "*Is* there a shortage?" An open- and fair-minded perusal of the textile trade papers, and of the textile sections of daily trade papers from about the middle of August, 1914, to date, leaves the question as to an actual shortage very much open to doubt, with the chances for a negative answer very favorable.

On pages 11 to 13 are selections from a large number of clippings which throw considerable light on that question.

It is only reasonable to believe that such perusal is very likely to result in the following summary of the situation: At the outbreak of the war our cotton mills were loaded up with cotton that cost them from 13 to 15 cents per pound; shortly after the outbreak of the war the price of cotton dropped until it soon reached a level of about 6 cents; *buyers* of colored cottons insisted upon prices for the manufactured goods based upon the then current prices of cotton; *sellers* of cotton goods insisted that the shortage of dyes was sufficient warrant for holding out for prices for colored cotton higher than the current prices of cotton would seem to justify; the buyers would not buy and the sellers would not reduce the prices. In the meantime dyestuff shipments which were curtailed in some of the months, increased, and for the year of 1914 the receipts of dyestuffs, *i. e.*, alizarin, etc., dyes, coal-tar dyes, indigo and anilin salts are $633,616 under 1913; that is, the totals for 1913 were $10,065,012 and for 1914, $9,431,396; in other words 1914 was 93.4 per cent of 1913. In 1912 the corresponding total was $10,386,703; *i. e.*, 1913 was only 96.9 per cent of 1912 or $321,691 short of 1912. No one complained in 1913 that this shortage as against 1912 was due to the American chemist. The answer, therefore, is that there was *not* any serious shortage of dyestuffs. With that answer also falls the principal condition upon which the press of this country based its insistent demand for immediate dyestuff manufacture in this country.

In this connection it is of interest to note what Mr. William G. Garcelon, secretary of the Arkwright Club of Boston, which includes the treasurers' of cotton mills, said on January 13, 1915, to the Committee on Patents, House of Representatives:

"I presume there are mills all over the country who are suffering from a shortage of dyestuffs. The reports that I have are that the dyestuff men are struggling very hard to look after their customers, and they are succeeding, I think, for the most part. The difficulty perhaps goes deeper than the dyestuff question, because the mills cannot sell their goods. But if they could sell their goods here in this country or anywhere else they might buy more dyestuffs than they do.

"There is another problem, of course, that interests them, and that is the cotton market, a year's supply of cotton having been bought at somewhere between 13 and 15 cents, and on account of the war the price of cotton dropping to 6 and 7 cents, and the mills finding themselves stocked with high-priced cotton and the buyers demanding goods at the basis of 6 cent cotton. It is not, of course, a profitable situation for the mill people. The mills of New England, with exceptions where specialties are involved or where there are large contracts ahead, are not busy. Most of them are running on four and five days' time and curtailing at every possible opportunity, because of business conditions..... It (the Paige Bill) has been discussed, but if you had been in the manufacturing of cotton goods during the last three or four months and had been trying to work at the cotton end of it, and trying to work at the dyestuff end of it, and trying to work out your practice based on cotton which was bought at 15 cents, and which you could now buy at 6 cents, and had all the troubles—I will say this, that it would probably have been much better for the cotton mills of New England if cotton had remained at 12 or 13 or 14 or 15 cents, because we bought our cotton at 13 to 15 cents, and now the purchasers are trying to buy our goods on a basis of 6-cent cotton, and we are in a hole because of that."

THE UNITED STATES MUST BE INDEPENDENT

Collaterally to this supposed dyestuff shortage our press urged that American industries should be independent of Europe for such vital materials as dyestuffs. Probably on some sort of reasoning, such as that employed by Lord Moulton, *viz.*, that one dollar's worth of dyestuffs is necessary to the production of $100 worth of manufactured product. Granting that dyestuffs are really so important and that such an important constituent of a manufactured product should be manufactured in this country, brings us up to a discussion of the second question.

The dividends declared and paid by the German dyestuff factories in 1912 are in the neighborhood of 10 per cent on the annual turn-over. For the purpose of discussion, let us assume it is 25 per cent and let us assume that the man who makes this $100's worth of manufactured product makes 10 per cent or $10 profit on that. The textile maker, therefore, makes $10 where the dyestuff maker can make 25 cents, or more likely 10 cents if he can manufacture as cheaply as can the German. The American dyestuff and chemical manufacturer is not and has never been attracted by that possible 25 cents profit. The textile maker is spending that dollar anyhow to somebody; the American dyestuff and chemical maker does not care to make that dollar's worth of commodity. It is of no consequence to him in his business; he is making a living some other way, but the textile maker says it is a matter of life and death to him to get those dyestuffs.

THE DYE USERS MUST MAKE THE DYES

An obvious question at this point is that if the dyes are so vital to the textile makers, and the American dye makers will not make them, why do not the textile makers invest their money in a dyestuff plant and charge up any losses that they may sustain thereby as insurance premium to insure the sale of their goods and the profit therefrom resulting, just as they make their own soap, if need be? There is no ethical nor professional reason against their so investing their money.

Even if the textile maker, under those conditions would just break even, he would still be a gainer; but the American dyestuff and chemical maker, would, under those conditions, be a loser, because he would be unable to return dividends to his stockholders, who have the very unfortunate habit of insisting upon dividends. If it cost the textile maker $1.50 to make a dollar's worth of dye, he would be out fifty cents; that is, he would have paid a 5 cent insurance premium to make sure of a 95 cent profit; if the dyestuff and chemical maker were obliged to sell a thing that costs him $1.50 at one dollar, the sheriff would very soon have possession of his property.

Granting, therefore, that the stability of our textile and allied industries demand that these materials be produced in this country, it also follows that the financial burden and risk connected with the manufacture of the dyes should fall upon them. To this responsibility I have yet to see from the dye users of this country any adequate or sufficient answer.

If it be the part of wisdom for textile makers not to enter upon the manufacture of dyestuffs in this country, even though dyestuffs are a matter of life and death for them industrially, then where is the wisdom in the chemical manufacturers of this country, who are making satisfactory money in other fields, risking millions of dollars of real money and years of effort and labor in an attempt to make 25 per cent at the very outside, when it would be money in the pockets of the textile makers to invest their capital in the very same venture and be ahead of the game, even if they lose 50 cents on every dollar's worth of dye produced?

I have no doubt in my own mind that the stockholders and the bondholders in our various chemical enterprises would resist any such venture on the part of their respective properties.

Throughout, since the beginning of the war, it seems that the sellers of colored cotton goods have been indulging in the cry of "wolf" many times more than once too often, and the buyers of cotton goods have not believed them; if the buyers of cotton goods, knowing the sellers of cotton goods better than the manufacturers of chemicals do, will not believe those sellers, what reason have the chemical manufacturers to believe the sellers, or, upon representations of those sellers alone, to invest huge sums of money and vast effort in an attempt to help the sellers?

PATRIOTISM AND BUSINESS

One answer that seems to be uppermost is that the chemical manufacturers should have a sufficient sense of patriotism to lose their money, and the money of their stockholders, in order to help out the textile makers. On this point the *Journal of Commerce* of October 5, 1914, says: "There are some merchants who think motives of patriotism should prevent large purchases of foreign goods at this time, but there is not as much patriotism in business as one liked to hope for and the cold fact of the situation is that constant appeals are made by the holders of foreign merchandise for an opportunity to unload here."

If patriotism will not induce buyers of cotton goods or sellers of cotton goods to pay more for goods made in the United States than for those made elsewhere, then why should patriotism cause the chemical manufacturers of this country to go ahead deliberately with a project in which they are sure to lose money?

WHY AMERICAN DYE MAKERS CANNOT COMPETE

But the answer to that is, "Sure to lose money, why?" and the answer to that question is a very long story, but it can be summed up as follows: The total world's consumption of coal-tar dyes of all kinds, the year round, and the world over is considerably below $100,000,000; ever since 1879, chemical and dyestuff manufacturers in this country have been attempting to get that business, or a portion of it, away from Germany; not only that, but the chemical manufacturers in Austria, Belgium, France, Great Britain, Italy, Russia and Switzerland have been engaged in the same effort, and all of them have failed; there is no real reason to look for glittering and immediate success now.

At the end of the year 1912 the world owed Germany $51,545,326 for dyes. Switzerland was second with a credit against the world of $3,794,898. Great Britain was the home of the coal-tar industry, but the Germans took it. At the end of 1912 Great Britain owed Germany $6,275,775 for this class of goods.

For the fiscal year ending June 30, 1912, German dyestuff factories declared and paid dividends of 21.74 per cent on their capital stock; for the fiscal year ending June 30, 1913, they declared and paid dividends of 24.96 per cent on their capital stock; in both years the dyestuff makers' dividends were fully 10 points ahead of the nearest income-producing division of the entire German chemical industry. In other words, the German dye industry is getting stronger all the time, not only relatively, but actually as well, for her competitors are becoming more and more dependent upon her; this is shown by the fact that Great Britain and France were hit more quickly and more acutely by the failure to obtain dyestuffs and dyestuff materials from Germany on account of the war, than was this country, in spite of the fact that both countries have branch factories of German dyestuff works within their borders. It must also be remembered that in the early history of the coal-tar dye business, France was an important factor, not only in the invention of dyes, but in their manufacture, but it, too, has had to yield to Germany.

THE INDIFFERENCE OF THE DYE USERS

Now the American chemical manufacturer is urged to transplant to this country as much of the German coal-tar dye industry as is needed to satisfy the wants of this country. To transplant the whole of it means that the American chemist must learn how to produce on a commercial scale, at low prices and in high quality, over 1200 different chemical products, each distinct from the other, each calling for separate manufacture and close and careful supervision of each step. The textile makers could make the problem a great deal easier for the American chemical manufacturer by making up a statement of the chemical nature of all dyes that they use, the amount used annually of each, and the average prices at which they have been purchasing them. Should it then turn out that the American textile makers could be satisfied with, say 400 out of the 900 dyes, it might very well be that 200 of the 300 intermediate products would be sufficient, and that would reduce the difficulty of the dye manufacturers' problem by 50 per cent. This is not an unreasonable expectation since seven colors have been able to do substantially all the tinctorial work of the 86 different colors used in food coloring prior to their prohibition by our Federal and State Governments. The textile makers decline absolutely to coöperate even to this slight extent.

Surely compared with the demand on the part of the textile makers that the chemical manufacturers invest not less than $5,000,000 and spend a year or two, or even more, in making the 900 different dyes and the required intermediates, the request on the behalf of chemical makers that the dye users furnish some dependable statement as to the actual consumption, both as to kind and amount, and the prices thereof, is a very, very vanishing quantity. The textile makers and other dyestuff users could prepare such a list at a total cost to them of less than $1000. If the users of dyestuffs are so reluctant about this small expenditure of money and trouble in order to simplify the dye maker's problem by over 50 per cent, representing millions of dollars of real money, the conclusion does not seem to be wholly unjustified that these users of dyestuffs have cried out long before they were even hurt, and that the extent to which they are hurt is not worth $1,000, for the purpose of ascertaining how conditions can be remedied. It is difficult, for me, at any rate, to believe that since the users of dyestuffs in this country will not go to that slight expense, they are very seriously hurt, if they are hurt at all.

THE PUBLIC AND THE DYE-INDUSTRY

Now the public at large has a right to know what it would mean to them to have $10,000,000 worth of dyestuffs produced in this country; roughly it would cost over $5,000,000 of capital and would not, at the very outside, employ to exceed 7000 people all told, in all divisions of manufacture, sale and distribution of the dyes and the necessary chemicals therefor, and would result in a diminution of our import business by only 0.4 per cent.

I say in all seriousness that this agitation on the part of our press, and this public clamoring that the chemical makers of this country should at once make coal-tar dyes in this country, is very much of a tempest in a tea-pot, and I believe that the presentation just given, is ample justification for anyone's taking the position of "Doubting Thomas." I, at any rate, have come to the conclusion that if coal-tar dyestuffs *must* be made in this country, the users of the coal-tar dyestuffs are the ones who should foot the bill for the venture; they should go out and get the money, and they should stand the losses that are bound to result, since they are in a position to absorb those losses without substantial harm to themselves. Failing that, the public at large must foot the bill.

The *Wall Street Journal* of December 28, 1914, says: "Users of dyestuffs in quantity are more or less indignant over the fact that manufacturers in this country are dependent upon other countries, and Germany particularly for the dye supply. They ask: 'Why haven't our chemical companies experimented sufficiently to produce synthetic dyes, pharmaceuticals products, essential oils and synthetic perfumes, in the production of which Germany seems to have had almost a monopoly?'

"The users of dyestuffs say that the General Chemical Company, with its cash resources and its extra cash and stock dividends yearly, and other companies in a similar position, ought to have had sufficient initiative to use a portion of their large profits in experimental work, which would have permitted us to manufacture synthetic dyes without recourse to other countries and would not have permitted American manufacturers to suffer severely when imports were checked by the war. They state that the interests of manufacturers of the country should have been placed ahead of large immediate profits and unusual dividend returns to stockholders." This, in my opinion, is a childish statement.

On January 7, 1915, the *Indianapolis News* said: "If the chemical and dye manufacturers are too timid to seize what appears to many to be an exceptional industry they cannot be forced to do so." It is a great relief to know that the chemical manufacturer must not spend his money and cannot be forced to spend his money as someone else may dictate.

SMOKE DOES NOT MAKE DYES

The daily press did not discover the coal-tar dye industry, nor did the daily press first bring the information of the existence of a coal-tar dye industry to this country. Some of the information upon which the *Indianapolis News* bases its view, that many regard this as an exceptional industry, is probably of the same order of accuracy as that contained in an article by George H. Cushing, in the November issue of the *Technical World Magazine*. On page 335, Mr. Cushing has a picture of the smoke stack of a power house, from which a cloud of smoke emanates. Under this cloud of smoke he has written "Throwing away products we buy from Germany; all of the aniline dyes are by-products of coal; Pittsburgh, Cincinnati, Chicago and Cleveland belch great vats of gorgeous colors into the air daily, and then send all the way to Germany to buy a supply." The *Literary Digest* for Nov. 7, 1914, prints the same remarkable news with approval.

Mr. Cushing, the editors of the *Technical World Magazine* and the editors of the *Literary Digest*, seem all of them to have forgotten the distinction between combustion and distillation. For those in a position such as theirs to attempt to represent to the American public that you can make dyestuffs from the smoke issuing from a chimney is the rankest kind of nonsense, and cannot be properly termed anything else but trash; it cannot be justified on any pertinent ground whatever.

It would probably astound these gentlemen to learn that one single coal-tar dye plant throws away the smoke from 22 chimneys every day and never makes an ounce of dye from the 800 tons of coal they burn daily, but sends fully 250 miles away to get coal tar and coal products for making dyes; nevertheless, such is the fact.

Any elementary text book on chemistry describes and insists upon the difference between combustion for power purposes and distillation for tar production purposes, yet these wonderful discoverers of new truths airily wave such fundamental distinctions aside, and mean to tell the American chemist that all that needs to be done is to put a fly-net over a chimney and get dyestuffs; because such trash is the foundation of the view of many that the dyestuff business is an unusual opportunity for American manufacturers, the *Indianapolis News* says the chemical and dye manufacturers in this country are timid, and the *New York Times* of September 5th, says they need more "spunk." Anyone who knows the facts, knows that the American manufacturer is wise in keeping out of any attempt to get into the entire dyestuff business. The chemists and chemical manufacturers of the entire world, outside of Germany, have been unable to take the dyestuff business away from Germany. In fact, they have been progressively losing to Germany. Millions of dollars have been expended in an effort to take this business. If the American chemical manufacturer declines to get into an undertaking of that sort and with that antecedent history, it is wholly unreasonable to accuse him of timidity.

Those who publish our daily papers are in the printing business, yet these publishers do not do all kinds of printing; otherwise they would print all of the $1,500,000 worth of lithographed labels that come into this country, principally from Germany, every year. Are the owners of our daily papers too timid and too devoid of spunk to print lithographed labels? It seems to many that there is an exceptional industry. I presume that the owners of the daily papers would feel rather ruffled if someone were to come up to them and tell them, as a piece of real news, that this country imports $1,500,000 worth of lithographed labels a year. If so, why should the chemists of this country patiently listen to such alleged exceptional industries as the daily press seems to believe that it has discovered?

ENGLAND REQUIRES PROTECTION

The *Indianapolis News* in the same issue opposes any protective tariff on dyestuffs on the ground among others that "The demand for independent manufacture of needed chemicals and dyestuffs has met with response in England—and England supports a policy of free trade." Now, as a matter of fact the response obtained in England is negative—almost absolutely negative. The dye users decline to contribute to a dyestuff-making venture, they decline to contract for any future deliveries, they decline to commit themselves in any way whatever to the support of any such policy, even though the British Government offers to raise one-half of the needed capital which was quoted at $15,000,000 (afterward reduced to $10,000,000); the British Government stands ready to contribute $7,500,000, or $5,000,000, and yet the users will not raise an equal sum. Why? The answer is that they insist upon protection; they want a protective tariff so high that when the war is over Germany can never sell in Great Britain. Russia is reported as attempting the same thing but so far without success.

GERMANY INDEPENDENT

The *Boston Evening Transcript* of December 21, 1914, says the following: "It is not a question of raw material, because we send to Germany more than one-half of what she uses in keeping us at her mercy. Her dyestuff industry has fattened upon our culpable indifference to the interests of our own people." The facts are that the United States *never did* supply Germany with any part of its coal-tar raw material. The facts, further, are that, as far back as 1905, Germany was utterly and absolutely independent of any nation on earth for any of its coal-tar raw materials. That was true for 1912 and for 1913, and there is no reason to believe that it is not true for the years intervening between 1905 and 1912. Germany made herself thus independent in the middle of the nineties.

The remedy that some of these newspapers and other equally ill-informed persons suggest is to alter the policy of our patent laws by introducing requirements for compulsory working. That is, by thus radically altering our policy, we are at once going to get a coal-tar dye industry.

THE BRITISH WORKING CLAUSE

France, in the early days of the coal-tar dye industry, was an important factor in the invention and in the manufacture of dyes; the same with Great Britain; France has always had a drastic working clause; in 1907, the British working clause was brought about at the insistent agitation of dyestuff makers of Great Britain, and they promised, in effect, to the British public that if that working clause were enacted into statute, an independent British coal-tar dye industry would spring up at once. After the law had been in operation six years and a half and Great Britain could no longer deal with Germany, what was the result? Was Great Britain able to supply its own needs of coal-tar dyes? Certainly not. Was France? Certainly not. Now since neither of these countries was able to supply its dyestuff needs, when it could no longer trade with Germany, was the working clause the cause of that condition? If not, what was? Certainly the working clause did not prevent that condition from arising. If the British working clause, the last, and presumably the best of the 56 measures now in force attempting compulsory working, absolutely and utterly failed to produce in six and a half years a coal-tar dye industry, when it had at that time five coal-tar dye factories of its own—each of them at one time or another making some of their own intermediate products and some of them at times even exporting to Germany—if those five British dye works *plus* the new British working clause could not produce the $6,000,000 worth of dyes a year that Great Britain imported in 1912, and make themselves independent of Germany, on what grounds and by what course of reasoning has anybody the right to assume that if we were to put the British working clause bodily on our statute book, we would create a large coal-tar dye industry, at once, or within *any reasonable* time?

In a paper entitled "Compulsory Working of Patents" written by Oliver Imray and Hugh Fletcher Moulton, both of London, and read before the International Association for the Protection of Industrial Property at its Convention in London in June, 1912, they sum up the effect of the British working clause as follows: "The results attained are, therefore, infinitesimally small compared with the large number of existing patents (100,000) even after deducting from this number those patents which may be considered of minor importance, and this in itself is an absolute proof of what a small call there was for this very serious and drastic alteration of the law, an alteration practically admitted by all countries from many years' actual experience to be a mistake."

At the meeting of the Imperial Industries Club of Great Britain, April 1, 1914, the compulsory working of patents was discussed. No one speaking in favor of the 1907 British Act named any specific cases of any new industries being brought to Great Britain thereby. Those speaking against the Act referred to case after case where foreigners revoked the British patents and then dumped foreign-made goods on the British market. Lord Moulton said of this British Act: "It is no use arguing about legislation of that kind. It is self-condemned."

Those who have spoken favorably of this British Act with but one or two exceptions have colored their statements; for example, one new plant was represented as employing 1600 people—it employed 37; another represented at 600 employees, employed 60. There are no official figures as to the real effect of this Act; the only figures are those of real estate agents having land and factories for sale; under those circumstances their fall from truth is understandable, but it does not heighten their credibility.

While the debate was on as to this British working clause the rosiest predictions were made, and I remember distinctly that it was promised that $500,000,000 of new capital would be brought into Great Britain on account of this working clause, and that hundreds of thousands of British would receive fresh employment.

Shortly after the enactment of the British working clause there was a considerable scramble among non-British corporations for opportunities to work in England, and that was looked upon as a great confirmation of the wonderful efficiency of that particular Act.

After two years of full operation, and under date of March 23, 1911, the *London Times* says: "Some fifty firms have commenced or are about to commence work under the Act, and the new factories involved a total outlay of some $4,000,000. It is hoped that employment will in this connection be found for 7,000 additional men, and that the wages paid to them will total something like $4,000 per week. Among the new industries are metallic filament, electric lamps, cinematograph films, aniline dyes, mercerized cotton, foods and medicines, oxygen, clay glaze. The foreign firms principally represented are German and American." That is, $4,000,000 came in instead of $500,000,000. For 50 firms that makes an average outlay of $80,000 per firm; this is probably four times the truth, at that. Under date of Sept. 26, 1914, the *Textile Manufacturers Journal* quotes as follows, on page 6, from the *Textile Mercury* of Manchester, England: "OPENINGS FOR NEW INDUSTRIES—A few years ago every one was full of hope of the foundation of new industries in our midst. The occasion was the passing of the Patents Act of 1907, which, for awhile, appeared to threaten the validity of foreign-held British patents. Municipalities, dock, railway and estate companies saw what they took to be an opportunity, and they went about to meet it. They issued books and advertisements in furtherance of the claims of their situations in order to catch the eye of capitalists who might entertain the idea of opening English works. For reasons into which it is unnecessary to enter, the result from these efforts was somewhat disappointing. The act did not lead to the establishment of any large number of new factories on British ground, but the facts that the anticipations existed and efforts were made deserve to be remembered at the present." Whatever the cause, the fact is that England today cannot make and does not make her own supply of dyestuffs.

Furthermore, it must be remembered that on July 13, 1832, the President of the United States approved an Act compelling all foreigners to work their patents in the United States under penalty of automatic cancellation. That Act was repealed July 4, 1836; it died at the tender age of three years, eleven months, and twenty-two days. If it was bad policy for us then, and experience proved it to be, why should it be good policy for us in 1915 to try the same thing over again? It has not worked in any of the 56 countries that have tried it. Why should it be successful after so many failures under present conditions, and why should it be successful when the old conditions, under which it invariably failed, return?

Another thing that must not be lost sight of is that when we put such an Act upon our statute books we expose ourselves to retaliatory measures, and retaliation may take place just as Germany and France retaliated upon Great Britain for the working clause of 1907.

From the *London Times* of March 23, 1911, just quoted, it appears that Germany was not the only country hit, but that we suffered with it.

The transplantation of the coal-tar dye industry to the United

States is not a question of patent protection; it is nothing but an economic question, a plain matter of dollars and cents; those products can be made in this country if persons will buy those products at a fair margin of profit over the cost of domestic production, and since we know in advance that the cost of production here will be above cost of production elsewhere, plus any prevailing import duty, why should we go to the costly venture of spending millions of dollars to prove the obvious?

As a matter of fact, the whole world's coal-tar dye consumption is about enough to make a decent-sized business for one country. Ordinarily it is best to do the world's work where it can be done best and to transport the products from their place of manufacture to their place of consumption. If it be necessary, for other reasons, that these products should be made elsewhere under conditions economically less favorable, then those who want those products made at such economically unfavorable place should bear the burden, but that is precisely what the dye users do not want to do; they want someone else to foot the bill.

KEEPING TWO MILLION PEOPLE AT WORK

The textile makers say that if they do not get those dyes, 2,000,000 people in this country will be thrown out of work, and in order to prevent that, the chemical manufacturers of this country must go down into their pockets for millions of dollars. Now, who brought those 2,000,000 people into the textile business? Who has the moral responsibility of keeping those 2,000,000 people employed? Is it too much to ask the textile maker to give up, say 5 per cent of his profits to keep his word and live up to his moral obligations, or should the chemists of this country furnish millions of dollars to enable the textile makers to keep their word with the making of which the chemical manufacturer is in no wise concerned? Is it patriotic to decline to give up 5 per cent of your profit in order to keep 2,000,000 people at work, for which 2,000,000 people you are morally, directly, responsible? Is it unpatriotic to decline to furnish millions of dollars to aid in the keeping of a promise with which you had nothing whatever to do, and from whose keeping you have nothing whatever to gain?

From an economic, a moral, or a patriotic point of view, the responsibility for and the financial burden of making coal-tar dyes in this country rests squarely and solely upon the users of dyestuffs, and in no wise, whatever, rests upon the chemists or the makers of chemicals in this country.

CONCLUSION

To bring the matter up squarely before you let me recapitulate: The 10,000 chemists in the United States are engaged in pursuits which affect over 1,000,000 wage-earners, produce over $5,000,000,000 worth of manufactured products and add $1,725,000,000 of value by manufacture each year; the business in products of and for chemical industry between the United States and Germany alone in 1913 provided 5 per cent of our total foreign business and 13.8 per cent of our balance of trade for that year. Please bear in mind that I am not by any means attempting to claim all the credit for this for the chemist; all that I ask is that his claims to recognition for intelligent, active and effective collaboration in bringing about those stupendous results be not thrown aside as worthless and that he shall not be made the target of unjust criticism because in 1914 there was a shortage of about $600,000 or 7 per cent in coal-tar dyes and because cotton dropped from 15 cents to 6 cents.

Much more could be said of the chemist and his contribution to the effective every-day labor of this work-a-day world but time and space forbid. I am sure that this short sketch of the chemist's activities, his hopes, his aims and his work will serve to create a wider interest in him and will result in according to him the credit to which he is entitled, namely, that he pulls more than his own weight in our nation's boat.

SELECTED QUOTATIONS BEARING ON DYE SHORTAGE FROM DAILY PAPERS AUG. 15, 1914 TO FEB. 20, 1915

1—AUG. 15, TEXTILE MANUFACTURERS' JOURNAL: In the meantime it is highly improbable that there is cause for any hysteria on the part of consumers .....

2—SEPT. 3, NEW YORK SUN: Alarming statements were made at the meeting (of representatives of the National Association of Hosiery and Underwear Manufacturers) regarding the shortage of dyes. Assurance was given by local (Philadelphia) agencies of German dye makers, that dyes are coming down the Rhine, but other jobbers reported that the dyes were not coming to America.

3—SEPT. 4, DAILY TRADE RECORD: Wrote one concern, "We will leave it to you to see that we get dyestuffs as ordered. The question of price is not disturbing us in the least."

4—SEPT. 19, NEW YORK EVENING POST: There has been little difficulty experienced in securing dyes to carry through for several months.

5—SEPT. 20, NEW YORK TIMES: A calmer survey of the conditions resulting from the war has removed some of the earlier apprehensions. The scare on the subject of dyestuffs, for instance, has spent its force now that supplies from abroad are coming in with some regularity, and it has been shown that there was no such scarcity of the materials in this country as not a few were led to believe.

6—SEPT. 21, JOURNAL OF COMMERCE: The situation in regard to dyestuffs is still disquieting. The prices on certain colors have gone up and other colors have been withdrawn from the market entirely.

7—SEPT. 24, JOURNAL OF COMMERCE: It seems difficult to make the truth about dyestuffs known to buyers of cotton goods. Political and business factors of an unusual character are at work to becloud the truth and all users of colors and all sellers of colored goods complain of the harm that is being done...... It is possible to publish on the very best of authority that leading finishers, printers and dyers regard the dyestuffs outlook seriously...... Unless a distinct change occurs in the next three weeks (*i. e.*, by Oct. 14th) some large printing establishments will be forced to close a substantial part of their works.

8—OCT. 1, JOURNAL OF COMMERCE: We have contracts with many of the leading dyestuff concerns and have found, with one or two exceptions, that they have taken no advantage of the present situation, have lived up to their contracts and in many cases have secured dyes and chemicals at no advance in price for mills, with whom in the past they have done no business, so that the former might continue manufacturing.

9—OCT. 2, JOURNAL OF COMMERCE: In colored cotton lines prices rule steady because the dyestuffs scarcity is a real factor and supplies of dyestuffs are being exhausted from week to week. ... the representatives of the largest textile finishing plants in the market declare that the situation is growing worse with them every week. ... There is noted at the same time unwillingness on the part of buyers to regard color scarcity as a serious matter, and manufacturers say they can only await developments in silence.

10—OCT. 4, NEW YORK TIMES: ... unless the tie-up of dye importations is broken by next February the textile and printing trades will be in a desperate way.

11—OCT. 8, NEW YORK TIMES: That dyestuffs in considerable quantities are moving inland through this port without examination and appraisal by the local custom officials was learned yesterday on the best of authority.

12—OCT. 14, JOURNAL OF COMMERCE: The cautious production of printers and other large users of colors in textiles is finally assuming proportions that command the attention of buyers of goods, as well as manufacturers of gray cloths. Printers will not produce goods on their own account, and thus tie up coloring matter that may be more profitably used in other directions if present prospects for limited supplies of dyestuffs continues. This fact is being thought over by some buyers, and those who were in the market were less disposed to pooh-pooh the attitude of sellers of goods of this class.

13—OCT. 17, TEXTILE MANUFACTURERS' JOURNAL: Prints, both staple and fancy, are being held at stiff prices on the ground of higher-priced dyes which counterbalance lower cotton. ... The end of indigo for denims is in sight ....

14—OCT. 17, TEXTILE MANUFACTURERS' JOURNAL: ... all the major industries using the products of his (dyestuffs and chemicals) house were now evidently impressed with the fact that the supply on hand and that due to arrive in the shipments expected would take care of their running needs, and that buyers from these industries no longer were eager to secure as much coloring matter and chemicals as they could in fear of a sudden cutting off of all supplies.

15—OCT. 22, JOURNAL OF COMMERCE: The hopes of dyestuff users are centered now on what will be brought into this country by the two ships reported as ready at Rotterdam for anything the German Government will permit to come through. ... There are some dyes filtering in all the time, but generally speaking the position of large dyeing and finishing concerns is just what it was a month ago with possibly this difference: The volume of new business offered to dyers and finishers is diminishing, hence it is possible to say that the supplies of dyes on hand may last a little longer than was estimated two months ago, when goods were being rushed to finishers in anticipation of a dyestuffs shortage.

16—Oct. 24, Journal of Commerce: ... the prices asked for dye-stuff and other chemical supplies are so high that the normal gain from cheap cotton is being almost wholly offset.

17—Oct. 24, Textile Manufacturers' Journal: Shipments received to date have in most instances enabled local houses to supply customers with their usual quantities of dyes and chemicals without materially decreasing stocks on hand in this country at the beginning of the war.

18—Oct. 28, Journal of Commerce: Some large mills have already ceased producing certain lines pending the securing of additional dyes, and other mills have shut down a part of their machinery to conserve the limited supplies of dyes on hand. Buyers still refuse to take the dyestuff shortage as a serious matter which is likely to affect merchandizing. .... According to the most reliable mill advices, the time is near at hand when additional dyestuff supplies will have to come from abroad, or a very general curtailment of the colored goods trading will be seen.

19—Oct. 29, Journal of Commerce: Many large plants have not enough dye on hand to supply them for three weeks if they are to go on using the stuff in normal volume. They will shut down on the production of colored goods unless they receive dyes before the first of December. ... How to make buyers see the situation as manufacturers see it is a question, but it will probably be the case as in other times, that scarcity will be acknowledged only when prices begin to rise and not when they are maintained at any given level. Prices on standard prints, ginghams, denims, tickings and other staple colored cottons have not been revised, save that here and there some manufacturer wants business to move stock goods, to secure cash for the purchase of cotton, or to provide enough business to use up the dye on hand.

20—Oct. 30, Journal of Commerce: There does not seem to be any ground for hoping that colored goods will be revised to the same relative levels seen in uncolored goods, as the costs of dyes and chemicals have risen out of all proportion to other values. ... where colored lines are wanted, business in a great many cases will have to be accepted subject to conditions in dye-stocks when the orders are taken up at the mills.

21—Oct. 1914, Textile World Record (p. 154): meeting the dyestuff famine in england. How to obtain a sufficiency of dyestuffs in view of the situation of German trade is almost as acute a problem for England as for America (p. 158). shortage of dyes in england. We may start this article with the statement that there is no shortage of dyes.

22—Nov. 5, Journal of Commerce: Mill agents are unable to receive assurances from mills that dyestuffs will be plentiful for the early part of the year and they are still very guarded in their commitments. In several instances orders for certain colored goods are being declined. Thus far this condition has not influenced buyers to any extent.

23—Nov. 6, N. Y. Commercial: Handlers of well-known brands of dress ginghams are getting more business than they were, and report that the dyestuff situation is slowly improving ....

24—Nov. 8, N. Y. Times: Whatever uncertainty there was regarding the procuring of all kinds of dyestuffs in sufficient quantity and at regular intervals has now been dissipated. With the removal of the doubt, also, has vanished any real pretense for much, if any, increase in price for the materials above the normal.

25—Nov. 10, Journal of Commerce: It is certain that most of the leading manufacturers of colored goods will ask no questions as to prices if they can be assured of supplies, as the time is at hand when many looms will be idle unless dyestuffs supplies come to hand.

26—Nov. 11, Journal of Commerce: Some mills making colored cotton goods are instructing agents to sell when they can at the best prices obtainable in order to keep stocks down. While dyestuffs are scarce and high the mills recognize that buyers are not much influenced by the dyestuffs situation....

27—Nov. 11, Daily Trade Record: Many finishers reported their supply of colors would carry them only until the first of the year, others until February. No one reported that the colors would carry them past April.

28—Nov. 13, New York American: Paterson silk manufacturers declare that at present there are dyes in sufficient quantity to last the silk, cotton and woolen industries in this country a long time.

29—Nov. 14, Daily Trade Record: Experts in textile dyeing, with special reference to silk, are recalling predictions at the opening of the war, that no textile mill or dye-shop would have to close because of a shortage of dyes, and are asserting that they were undoubtedly accurate in their prophecy. And now, as one of them said yesterday, the danger is almost past.

30—Nov. 14, Journal of Commerce: Within a month it will appear to buyers of colored goods that the dyestuffs problem is a very serious matter, as some large producers of colored goods have already reached the point where they must shut down if dyestuffs in large quantities do not come forward before the first of December.

31—Nov. 16, Journal of Commerce: Investigation as to the importance of dye-materials from various European ports into this port during the month of October discloses the interesting fact that despite the reported scarcity of dyestuffs alleged to be due to the blocking of the German ports, there was brought into New York a greater number of packages, having a slightly higher value than was brought in during the corresponding month of last year when war conditions did not prevail.

32—Nov. 17, Boston Post: At the beginning of the present European war the cry went up that dyes, which are purchased chiefly in Germany, would be unprocurable and that the textile industry would be seriously injured. But the cloud in this direction has for the moment passed, and in all probability before another has time to gather, the exigency will be provided for.

33—Nov. 19, Journal of Commerce: Uneasiness is shown by some buyers because prices on prints, ginghams and percales are not revised downward. If selling agents were not being held back by the fact that mills will not guarantee deliveries until the color and dyestuffs question is more settled, they would revise prices at once. .... It seems useless to agents to try to impress buyers with the fact that some of the largest textile users of dyestuffs are on the verge of closing and have already shut off the production of several important colored lines. The only impression they expect to see effective is the one that will be made when goods ordered are not delivered because dyes cannot be had for making them.

34—Nov. 22, New York Sun: According to mill men in this section (Boston) of the country the dyestuff situation is today more serious than at any time since the European war started. This afternoon the Pacific Mills at Lawrence employing 2000 hands, was forced to shut down for at least a week on account of a lack of dyestuffs. ... the prospects of adequate supplies of dyeing material are poorer now than at any time in months.

35—Nov. 23, Providence Evening Tribune: "boston, Nov. 23—It will surprise most people to learn that the dyestuff situation is today more serious than at any previous time.....

The dyestuff subject is ultra-technical and presents ramifications almost baffling of expression in every-day description. But it seems there has been a 'nigger in the wood-pile' in this dyestuff situation all along which the public has practically never heard about."

36—Nov. 24, Journal of Commerce: In the cotton goods division it is no longer doubted that large mills using dyestuffs are confronted with the necessity of shutting down in order to conserve the limited supplies of dyes on hand. That some plants would be kept running if orders were coming in normally is admitted by agents, but in the absence of normal orders idleness in the factories has become a necessity, which comes now instead of later, when dyes are actually exhausted.

37—Nov. 25, New York Times: There has been a marked improvement in the demand for colored cotton goods on the part of the wholesalers in the last few days, and, as a result, the anticipated price revision on these goods have become realities. For example, it is now possible to get a Southern 4.30-yard Chambray fully a cent a yard under the figure which prevailed in September 1, while staple ginghams of Southern make have been dropped a half a cent a yard in the last sixty days. A drop of about a half a cent a yard has also been recorded in Southern denims. Eastern prices are firmer, but it is figured that downward revisions of them are not far off.

38—Nov. 26, New York American: Just at present he (a leading shirt manufacturer) said printers are at a loss as to how to cope with the shortage of dyestuff, which is growing larger each day. In the past week or two, several of the largest mills shut down on this account while a number of others radically reduced their running time.

39—Nov. 28, Textile Manufacturers' Journal: The shortage of indigo is one of the notable features of the present dyestuffs situation.

40—Nov. 30, Journal of Commerce: Many of the large mills making colored goods have less than a six weeks' supply of colors, while many cloths have already been withdrawn from the market because duplicates cannot be produced until certain dyes come in. These facts have been so often repeated that buyers disregard them as of no consequence and will probably so continue to regard them until an actual demand for goods cannot be met.

41—Dec. 2, Journal of Commerce: The dyestuffs situation so far as hosiery is concerned ... is as critical at present as it has been since the war began, despite some views to the contrary.

42—Dec. 2, Wall Street Journal: A textile authority says to the Boston News Bureau: "The dyestuffs situation is undoubtedly growing worse daily. There is nothing in sight or on the way to relieve the situation. Some mills have more dyestuffs than others, but unless a sudden exportation of German dyes starts and starts right away there will be a gradual withdrawal from the market of line after line of staple goods. The greatest shortage at present is in blacks, indigoes and fast colors. Substitutions are being made where possible and with some success. But there is a limit to what can be done in this direction. If conditions continue without a break it is a matter of weeks and not months before the consuming public will find an acute shortage of standard colored goods."

43—Dec. 4, Journal of Commerce: It is understood that the mills can be kept in operation for about sixty days. If no further dyes suitable for cotton goods of this class (denims) come in, the large plants must shut down.

44—Dec. 8, Daily Trade Record: An important textile authority is quoted as follows: "The first real flag of distress has been hoisted in the dyestuff situation. This has been the withdrawal from the market of all lines of denims manufactured by the two largest denim mills of the country. These mills state that present orders will exhaust their supplies of dyestuffs and they have no means of replenishing. These two great mills have about two months' work ahead and will then probably have to shut down.

"The average retailer in this country appears to have a very faint comprehension of the critical situation in dyestuffs. He was told the story of the danger of cutting off of supplies at the very outbreak of the war. He was urged by the selling agents of the mills to stock up with this line and that of colored goods on the theory that there would be a famine in prints and other colored lines within a few weeks' time. But these jobbers and retailers have found themselves steadily able for four months, to buy all they wanted, and they have naturally assumed that this tale of woe was simply another device of clever salesmen to tempt them into placing large forward orders.

"And the curious fact is that in many lines of colored goods today, the very dyes of which the mills are most acutely short, are represented by manufactured stocks of goods on hand of which they have the largest supply. This fact will tend to postpone still further the general recognition of the dye famine which the mills are forcing."

45—Dec. 9, Daily Trade Record: At a meeting of the Dyestuffs Committee of the National Association of Finishers of Cotton Fabrics, held prior to the general meeting of the association, at the Arkwright Club yesterday, the proposed convention of users and producers of dyestuffs was discussed, and it was decided for the present that the matter would not be pushed. The committee is well aware of the serious shortage of dyestuffs, but does not feel that the shoe has yet pinched hard enough to bring it home to consumers. The responses to the circular letter sent out by Secretary Danner, to users and producers of dyestuffs, asking if they favored sending delegates to a general convention, were disappointing to the committee, and showed that the time was not opportune for a general convention.

46—Dec. 9, Daily Trade Record: The Glenlyon Dye Works, of Saylesville, R. I., are reported to have resumed the use of colors which were withdrawn several months ago, when the dyestuffs shortage first became acute. The Glenlyon is said to be in a position to put out its full line of yarn dyes again. J. G. Whitaker, manager of the Glenlyon works, is quoted as saying that the supply of fast dyes which the concern now has should last from four to six months, according to the demand of the trade.... There has been a heavy curtailment among colored goods manufacturers, both in the East and South, for some weeks past. This curtailment is still in evidence. It has been due partially to lack of orders for goods and partially to the shortage of dyestuffs. Manufacturers and finishers do not hesitate to say that if there was a normal demand for goods, the supplies for dyestuffs on hand would be cleaned up within a few weeks.

47—Dec. 10, Journal of Commerce: If they (the buyers) really show a need for goods and will place orders on which mills can predicate plans of future operations to the extent of stocks or dyestuffs on hand, it is thought quite possible that agents will make a revision that will meet immediate conditions. .... The fact that the largest printers are operating less than half their machinery is its own answer to the crisis in the dyestuffs situation with them. There are some of the large jobbing house buyers who are now very anxious concerning certain colored goods they will need for Spring. During the past week agents have had reason to know that buyers no longer regard the dyestuffs shortage as something to joke about.

48—Dec. 12, 1914, Textile Manufacturers' Journal: STOCKS STEADILY DEPLETED. SUPPLY OF COLORS WANTED GROWS CONSTANTLY SMALLER. .... DYESTUFF SUPPLY SMALL. CONSUMERS NOT OPTIMISTIC ABOUT FUTURE DEVELOPMENTS.

49—Dec. 30, New York Times: WILL DYES HOLD OUT? Factors in the piece goods market are rather puzzled over what the dyestuff shortage will mean during the coming heavyweight season. The tremendous amount of dyes required in filling the contracts let out here for army cloths will seriously deplete the small stocks of dyes on hand.

50—Jan. 9, Textile Manufacturers' Journal: The situation in some of our dyestuffs is desperate. There is no gainsaying it, and it behooves us to look the facts in the face and not squander time, which we could put to much better uses, in vain regrets and recriminations that our supply houses had not foreseen contingencies as they have happened and provided an unlimited stock of the colors which we need.

It is to be expected that American dyestuffs makers will largely benefit by these circumstances; but, on the other hand, it is doubtful whether they will have the courage of enlarging to such an enormous extent as to be able to meet the European deficit, since they must figure upon the probability that when peace is again established the Europeans will make every effort to regain the profitable American field.

BLEACHING SUBSTITUTE FOR DYEING—This leaves a clear-cut issue before us textile manufacturers: What we have not got we cannot make use of, and our commission merchants and jobbers and stores cannot sell. The public will then be forced to content itself with undyed goods, but this does not mean the raw, woven or knitted fibers, which would be too unsightly for wear. We can beautify them immensely by bleaching, and this will be the solution of our problem and the salvation of our textile industries. As long as we have white goods to wear we shall always be able to clothe ourselves in good taste.

51—Jan. 20, Journal of Commerce: Theodore Boettger, of the United Piece Dye Works of Lodi, N. J., the largest dyers of textile in the piece, told the members of the Jobbers' Association of Dress Fabric Buyers yesterday afternoon, who were holding their annual convention at the Waldorf-Astoria, that the scarcity of dyestuffs on account of the war, was not serious, although a scarcity really exists. The buyers of dress goods, Mr. Boettger said, could go ahead and conduct their business without interruption. At any rate, he said, they could let the dyers do the worrying.

52—Feb. 20, Textile Manufacturers' Journal: So far little if any machinery has had to shut down on account of inability to obtain dyes, but any reserve stock, either in manufacturers' or importers' warehouses, has absolutely disappeared.

90 William Street, New York City

COMPULSORY WORKING OF PATENTS IN THE UNITED STATES, GERMANY AND GREAT BRITAIN[1]

By BERNHARD C. HESSE

The United States Patent Act of July 13, 1832, for compulsory working of patents reads as follows:

"AN ACT CONCERNING THE ISSUING OF PATENTS TO ALIENS, FOR USEFUL DISCOVERIES AND INVENTIONS"

"Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the privileges granted to the aliens described in the first section of the Act, to extend the privilege of obtaining patents for useful discoveries and inventions to certain persons therein mentioned, and to enlarge and define the penalties for violating the rights of patentees, approved April seventeenth, eighteen hundred, be extended in like manner to every alien who, at the time of petitioning for a patent, shall be resident in the United States, and shall have declared his intention, according to law, to become a citizen thereof: *Provided,* That every patent granted by virtue of this Act and the privileges thereto appertaining, shall cease and determine and become absolutely void without resort to any legal process to annul or cancel the same in case of a failure on the part of any patentee, for the space of one year from the issuing thereof, to introduce into public use in the United States the invention or improvement for which the patent shall be issued; or in case the same for any period of six months after such introduction shall not continue to be publicly used and applied in the United States, or in case of failure to become a citizen of the United States, agreeably to notice given at the earliest period within which he shall be entitled to become a citizen of the United States."

That part of this Act preceding the *proviso* was introduced into the House of Representatives January 6, 1832; then it went to the Senate and there the *proviso* was added; then accepted by the House and finally approved by the President.

This Act was repealed July 4, 1836. No such compulsory provision has since been placed on our statute books.

Precisely why this Act should have been passed and then repealed is not now determinable since a thorough search through the records of Congress does not disclose any debate nor any committee report; my information is that in those days Senate

[1] Received March 1, 1915

proceedings were secret and records were not kept; detailed committee reports on patents do not begin until 1837; the House record merely notes introduction, the acts of reading and of passing.

GERMAN WORKING CLAUSE

Dr. C. Wiegand, of Berlin, in a paper entitled "Compulsory Working and Compulsory Licenses" published at p. 188 of the "Transactions of the International Association for the Protection of Industrial Property," for the meeting of June, 1912, says of the German Compulsory Working Act of June 6, 1911: "Under the provisions of the previously existing law a patent could be revoked, if the invention was not worked to a sufficient degree within the country, or at any rate everything done to secure this working. Opposition to this unconditional compulsory working was made by numerous manufacturers and lawyers, and as established by the arguments in support of the Law of June 6, 1911, it was shown that the system of compulsory working in itself led to an uneconomical splitting up of the source of production and that consequently the abolition of compulsory working was to be desired. The Imperial Government adopted this view in principle, but pointed out that so long as other important manufacturing countries, in which the German industries and German applicants for patents had important interests, retained their compulsory working provisions or introduced them afresh, a general abolition of compulsory working in Germany was not to be recommended. On the other hand, in all cases where another State was ready to accord the same benefit to German inventors, compulsory working should be abolished as against this State by treaty.

"There exist between Germany on the one hand and the United States, Switzerland and Italy on the other hand, treaties by which the subjects or citizens of these States, either generally or under particular conditions, are not subjected to the compulsory working provisions. The German Government, which in this matter sees eye to eye with the greater part of the German industry, is anxious to proceed further on the same lines and to abolish compulsory working by treaty with other important industrial countries."

The relevant and essential text of the German working clause of June 6, 1911, is given, in translation, as follows by Dr. Wiegand (*Loc. cit.*): "If the patentee refuses to another the permission to use the invention when offered remuneration and guarantee, the right to use the invention can be accorded (compulsory license) to the other person, if the grant of this permission is demanded in the public interest. The right to use the invention can be granted with limitations and be made dependent upon conditions.

"The patent can be revoked provided State treaties do not prevent this if the invention is exclusively or mainly worked outside the German Empire or the Protectorates. The assignment of the patent to another is without effect if it has only the object of avoiding revocation.

"Before the expiration of three years after the publication of grant of the patent, no decision can be rendered against the patentee."

BRITISH WORKING CLAUSE

In 1907 the British Parliament enacted a compulsory working clause. The following excerpts from the *Journal of the Royal Society of Arts* for 1908 and onwards show how the effects of that enactment were regarded.

Vol. 56, p. 143 (Jan. 3, 1908): "The new patent law requiring the production of patented articles in English works is having the anticipated effect in bringing German color manufacturers to this country."

Vol. 56, pp. 283–4 (Jan. 31, 1908): "It is seldom that an Act of Parliament has such an immediate and beneficial effect as that which seems likely to follow upon the coming into operation of the New Patent Act. Many foreign patentees are already negotiating with British manufacturers to carry out in the United Kingdom their British patents. Others have taken land for the purpose of erecting works in order themselves to work their British manufacturers. . . . .

"A well-known American company which holds British patents for the manufacture of safety razors, hitherto made solely in the States, have secured land in Sheffield, and expect to employ 500 hands as soon as their works are completed. Many other foreign manufacturers holding British patents, which they have hitherto worked solely abroad, are following their example. There is not the slightest doubt, writes Mr. Ivan Levinstein, in an interesting letter directing attention to what the new Act has already brought about, that the advent of these foreign manufacturers will mean additional employment for workers—the operative classes, highly trained engineers and chemists—and give a new impetus to British enterprise. Unlike its predecessor, the new Act is clearly worded, and leaves no loopholes for escape from its salutary and much-needed provisions."

Vol. 56, pp. 924–5 (Sept. 4, 1908): "This Act, the Patents and Designs Act, became operative on August 28th. Its principal clause runs as follows: 'At any time, not less than one year after the passing of this Act, any person may apply to the Comptroller for the revocation of the patent, on the ground that the patented article or process is manufactured or carried on exclusively or mainly outside the United Kingdom.' In future, foreign manufacturers, if they wish their patents to remain valid in Great Britain, will have to make the goods they sell within the United Kingdom. Otherwise their patents may be copied or infringed at will. Germany and the United States are particularly hit by the new enactment, and they are meeting the altered conditions by (1) building factories of their own in England; (2) acquiring premises already built for the purpose of carrying on their business; (3) arranging with British manufacturers to lay down plant and coöperate in the production of the special articles which are the subject of the patent. Already some thirty foreign firms—many of them conducting operations on a large scale—have begun, or are about to begin operations in this country, most of them choosing the North of England as the scene of their operations. It is said that as a rule the foreign manufacturer is providing a factory many times larger than is really necessary for the construction of his patented article, his explanation being that he cannot run works in England on patents alone, and he intends therefore to manufacture in this country goods that have hitherto been imported ready-made. So far as can be seen at present the Act must profit British labor. It is said in some quarters that these manufacturers, at any rate the German ones, will be worked by foreign staffs, but this is not the case at present with Messrs. Meister, Lucius, and Bruening (Limited) of Germany, a company with a capital of £11,000,000, which has just erected a new chemical factory at Ellesmere Port. Here all the workers employed are English, with the exception of a few German overseers. The working of the Act will be watched with keen and anxious attention, for British manufacturers are beginning to realize that foreign competition is about to invade their own particular territory, and that there will be a fair but strenuous fight on British soil for British custom. That is not a prospect that can be viewed altogether with anxiety when the perfection of German organization is remembered. The German things to be manufactured in England will be mostly aniline dyes, pottery, plant for gas making, rifles, plated goods, electrical contrivances, furnaces, sanitary appliances; the American, typewriters, safety razors, phonograph records, shoes, telephones, and wire roofing."

Vol. 56, p. 952 (Sept. 18, 1908): "It is seldom that an Act of Parliament works quite as its authors and supporters hoped and expected. The Trade Marks Act is one of the most striking illustrations of this truth. It may be that the New Patents Act will be another. It may bring the foreign competitor to even closer grips than at present with our manufacturers, and it may lead the inventor to resort more frequently to the secret process.....

"Independent discovery is now the only risk menacing a monopoly based on secret working, and the risk of independent discovery is usually not great; it is at least much smaller than that consequent upon betrayal or accident. It is quite possible, therefore, that one of the results of the Patent and Designs Act, 1907, will be largely to increase the number of inventions worked as secret processes."

Vol. 57, p. 212 (Jan. 29, 1909): "There has been some recent correspondence in the *Times* as to the probable effect of the revocation of certain patents on the ground of their not having been worked in the United Kingdom. The section was intended to encourage British industries, and was indeed welcomed as a Protectionist measure by the opponents of Free Trade. It is now urged that its probable result will be to encourage the manufacture of the patented article abroad and its importation into this country, it being improbable that manufacturers here will find it pays to produce it if the manufacture is unprotected by a patent. Thus the clause may now conscientiously be approved by Free Traders. Attention has also been drawn to the remarks made by the Comptroller, who, in delivering his judgment expressed the opinion that it was to the general advantage that the trade should be freed and the importer enabled to obtain the foreign manufactured goods readily. This doctrine, if carried to its legitimate conclusion, would seem to justify the abolition of patents entirely, and the revocation, not of an occasional patent, but of the Statute of Monopolies itself."

Vol. 57, p. 340 (March 6, 1909): "The great advantages to this country attendant upon the passing of the Patents and Designs Act, 1907, have not, so far, been sufficiently appreciated by manufacturers and merchants in the United Kingdom."

Vol. 58, p. 473 (March 18, 1910): "The expectation that the Patents Act of three years ago would result in foreign firms acquiring land and erecting buildings in this country to a considerable extent has already been verified. The Act came into force on January 1, 1908, and since then foreign firms have acquired land in England to the value of £188,650, and they have spent £290,750 in the erection of buildings and the housing of their work-people, and a further sum of £410,972 on plant, machinery and equipment. Thus in two years the Act has caused foreign firms to spend £890,372 in this country. Mr. Farmer, of Messrs. Leopold Farmer and Sons, who has given special attention to the subject, says that the Americans, Germans, Dutchmen, Frenchmen and Swedes have taken part in this commercial invasion, and he estimates that over forty firms are represented. Among them are manufacturers of matches, electrical apparatus, chemicals, pottery, pencils, mercerized cotton goods, musical instruments, roofing felt, incandescent gas mantles and rubber goods, all compelled by the Patent Act to make their goods in this country, to buy land, build factories, employ home labor, and pay rates and taxes. The works are scattered all over the country. They are in the metropolitan area, Middlesex, Kent, and Essex. In Cheshire several firms have established works on the Mersey; others are at Leicester bootmaking; others again at Warrington, Wolverhampton, in South Wales and Yorkshire. According to official figures some 8,000 people are employed as the result of the Act, mostly men, and the local authorities will benefit in the shape of rates substantially."

The accuracy and dependability of these statements is probably not very great. For instance, the combined capital of three German dye companies is given at 260,000,000 Marks and of two others at 160,000,000 Marks or 420,000,000 Marks for these 5 German dye companies. On June 30, 1912 the 21 German dye plants, inclusive of these five, had a combined total capital of 146,800,000 Marks. That is, the *Journal of the Royal Society of Arts* attributes three times as much capital to 5 plants as all 21 had together almost 4 years later; the German dye-companies have progressively increased their combined capital stock and have not decreased it.

The following tabulation shows four different estimates of fresh capital invested in Great Britain as a result of this Act:

	Pall Mall Gazette	London Daily Mail, Nov. 5, 1909	Jour. Royal Society of Arts, 1910	London Times(*a*) March 23, 1911 p. 21
Land	$ 500,000	$ 585,000	$ 943,250	....
Buildings	1,000,000	535,000	1,453,750	....
Plant and equipment	1,000,000	435,000	2,054,860	....
Totals	$2,500,000	$1,555,000	$4,451,860	$4,000,000
Number of firms	......	......	40+	50
Number of work-people	......	....	8000	7000

(*a*) Based upon reply to questions in the House of Commons at the close of 1909, made by the President of the Board of Trade; there are no official figures; official estimates alone are available.

In spite of much searching in Washington and New York I have been so far unable to locate any item-by-item statement for any of these lists. No doubt such lists exist but so far they have succeeded in escaping me.

I quote from private letters to me (B. C. H.) from England by a friend of over nineteen years' standing and dated February 8 and 12, 1915, after, for obvious reasons, having made certain indicated omissions and corresponding textual changes:

"Questions have been asked in Parliament once or twice, and I followed the answers with interest but they were purposely very vague, and gave no real information, but put the effect of the working clauses as great as possible in a vague way.

"A firm of estate agents, Farmer and Company, who did do a little business in selling land or a factory to people coming over here to work patents made the most of the Act and wrote to the papers with reference to it, thereby getting a free advertisement. They published tables, showing the effect of the Act, which were grossly misleading; for instance one factory appeared four times in the list with the nominal capital so that the capital was quadrupled. Again the number of work-people to be employed by it was estimated at 400, and this given four times made 1,600, instead of 37. Precisely the same sort of thing was done with reference to any other factory as to which I know anything. I cannot say whether the list was more accurate about factories of which I know nothing, but in any case these lists were absolutely worthless. The way in which this factory was given four times was this. It was given at first under the proper name—Chemical Works. Then it was given as a factory to be erected by Company A, a factory to be erected by Company B, and a factory to be erected by Company C. (Note: A, B and C companies *together* erected this *one* plant.)

"The ——— factory was similarly treated. The effect of the working clauses in the last New Patent Act has been infinitesimally small from the point of view of bringing about new manufacture in this country, and the employment of labor. In no case has the Act resulted in any manufacture in the coal-tar dye industry continuing in this country after the patent has lapsed; for instance, while ——— was patented over here it was made in large quantities, yet the last English-made ——— was sold two or three months before the patent lapsed, and so it has been with everything else. It is impossible to produce any permanent results by these working clauses. Again, a number of patents have been revoked under the new Act. In no case has this resulted in the manufactures being effected in England. The inventor has lost his patent but there has been no manufacture resulting over here.........

"I have now heard from London where I spent a few hours the day before yesterday, with reference to the compulsory working clauses. The Controller at the Patent Office assures me that there has been no official publication at all with reference to the effect of compulsory working.........

"The ——— Chemical Works bought 24 acres of land at

£1,000 the acre, but they did this with the absolute conviction that five acres would be amply sufficient for a factory merely to work the patents. Indeed, with five acres the coefficient of safety was three.

"The factory of the ——— Company at ——— is similarly very much larger than is necessary for working the patents. The site covers, I believe, 25 acres. I am not sure of the exact size of the site. They use, I should estimate, three acres."

According to the *Journal of Commerce* of November 4, 1914, the Farbwerke Hoechst plant in England employed fifty or sixty workmen at that time; statements have been made by supporters of this clause that these works employed 600 workmen.

On April 1, 1914, the Imperial Industries Club of Great Britain had a real in-the-family and heart-to-heart discussion of this Act and its effects. The complete report of that discussion is given below with acknowledgments to The Imperial Industries Club, whose official pamphlet has provided this material.

Since this Act was passed for the benefit of Great Britain's chemical industry and particularly with the hope and expectation of creating in Great Britain a real coal-tar dye industry and has failed of its object, a careful study of this discussion at this time must appeal to every American chemist and maker of chemicals.

90 William Street, New York

SYMPOSIUM ON COMPULSORY WORKING OF PATENTS AND DESIGNS IN ENGLAND[1]

By The Imperial Industries Club

THE CHAIRMAN: *My Lord Moulton and Gentlemen*—We have received letters of regret from the following, who are not able to attend this evening: Sir John S. Randles, M.P.; the Hon. Sir John Astbury; Lord Parker; Ivan Levinstein, Esq.; C. T. Needham, Esq., M.P.; the Right Hon. Lord Southwark; F. Whitley Thompson, Esq.; G. J. Stanley, Esq., of the Board of Trade; Harry Nuttall, Esq., M.P.; A. J. Hobson, Esq.; Ex-Master Cutler, of Sheffield; and from Sir Joseph Lawrence, a member of this Club and an old friend of ours here, the following telegram has been received. Sir Joseph says: "I deeply regret cannot join you. If present I should stoutly maintain compulsory working benefits this country by creating more opportunities for employment and I strongly support this policy and would strengthen it by Parliamentary means. Please read this to your meeting."

Gentlemen, I think that that is a very good opening for the subject which we are about to discuss and which I think you will all agree will prove a very interesting one. We are a comparatively small party this evening; but I think we are all interested more or less in the subject which we are going to debate. We are fortunate in having around this table gentlemen who are professionally, officially, and commercially interested in patent questions, and we are to have an opportunity of hearing, I hope, expressions of opinion which will voice both sides of the question. Because *at this Club we do not like things to be altogether one-sided*. Our purpose in meeting here is to try to thresh out matters in a friendly and convivial sort of way, and therefore we rejoice when the opener has some little opposition, so that those of us who do not take part in the debate are able perhaps to act as a jury of decision.

I am privileged to call upon Mr. Walter Reid, Chairman of the Institute of Inventors, to be good enough to open the discussion.

MR. WALTER F. REID, F.I.C., F.C.S.: *My Lord Moulton, Mr. President, and Gentlemen*—The reason I have been called upon to open this discussion has been stated by the Chairman, namely, because I happen to hold the office of Chairman of the Institute of Inventors; but I should wish for your sakes that you had somebody who is better able to place the arguments on behalf of inventors before you than I can do myself. I am very glad indeed to have the assistance of my old friend Sir Joseph Lawrence, because I was with him on the deputation to Mr. Lloyd George which resulted in the Patents Act that is now the subject of discussion, and that some of us, at any rate, wish to alter. Previous to that I had also taken part in a deputation to Mr. Gerald Balfour, when he was at the Board of Trade, when we also got an alteration of the Patents Act. I do not know whether anybody was satisfied with that alteration, but I have not heard of many, and that Act was very soon altered. I think, when we are on that subject, it is not quite right to say that Mr. Lloyd George on that occasion gave one of the first and most conspicuous instances of Protection to British industry. He really did nothing of the kind; he placed us on a Free Trade basis with other nations, because undoubtedly—I will not go into the figures on this question—at that time the bulk of the other nations, the most important ones, who were competing with us industrially and commercially, had compulsory working as one of the conditions of granting a patent in their countries. We for a very long time had no compulsory working: we had allowed foreign inventors here to acquire monopolies in certain branches of industry, and they had made use of those monopolies in a way which those who were acquainted with the details of the subject could no longer permit Great Britain to labor under the disadvantage of. On the occasion when we had the last deputation to Mr. Lloyd George a number of cases and details were given of industries that had suffered in Great Britain because foreigners had been granted monopolies here and had not worked the patents in this country, but, having the monopoly, they could demand from our own people prices which they at home could not obtain. A very familiar case was that of the alizarine industry, where our manufacturers here who had to use such dyes were paying about half-a-crown and the practical real value of the material was about sevenpence. Of course, our manufacturers were suffering there under a great disability as regards foreign competition because they required that dye; it was a dye which was necessary, and the wool dyers in Bradford and elsewhere had those excessive prices to pay whereas their German competitors had not.

Now, I think, if we consider that, it is a clear case where the British industry is handicapped and unfairly handicapped; and I would ask you to bear in mind that the first and original idea of a patent was a monopoly for the introduction of an industry into this country, and it was only at a later stage that the inventor was given a monopoly for the produce of his brains. Nobody will deny that an inventor ought to have something for inventing a thing; otherwise we should have no inventors in this country; they would go elsewhere. But I do think, myself, and, so far as I have been able to learn, and I think I am in as good a

[1] Report of the proceedings at the April dinner of the Club held at DeKeyser's Royal Hotel, Victoria Embankment, E. C., London, on April 1, 1914, with the President, Ald. Sir George Wyatt Truscott, Bart., J. P., in the chair. Among those present were the following: The Right Hon. Lord Moulton of Bank; W. Temple Franks, Esq., C. B.; Sir George Croydon Marks, M.P.; Sir R. Ellis Cunliffe, M.A.; Col. Sir John E. Bingham, Bart., V.D., J.P.; Sir Roper Parkington, D.L., J.P.; A. J. Walter, Esq., K.C.; James Hunter Gray, Esq.; H. A. Colefax, Esq., K.C.; G. Henry Wright, Esq.; C. E. Town, Esq.; Stanley Machin, Esq.; H. Hatfield, Esq., I.S.O.; Wm. Martin, Esq., LL.D.; Alex. Siemens, Esq.; Oliver Imray, Esq.; Alfred O. Goodrich, Esq.; Dr. Ernest J. Schuster; George Barker, Esq.; C. Freeman Murray, Esq.; The Hon. Hugh Fletcher Moulton; Laurence Rostron, Esq.; C. Urquhart Fisher, Esq., L.C.C.; J. King Stewart, Esq.; John Cutler, Esq., K.C.; J. M. Forbes, Esq.; Achille Bazire, Esq.; R. B. Dunwoody, Esq.; Louis Sinclair, Esq.; Francis E. Truscott, Esq.; James Webster, Esq.; W. Holmes Reddan, Esq.; R. A. Wallis, Esq.; Percy Richardson, Esq.; W. A. Vernon, Esq.; Dr. A. E. Rose; J. K. Foord, Esq.; C. Beatty, Esq.; Kenelm H. H. Smith, Esq.; Walter F. Reid, Esq., F.I.C., F.C.S.; Douglas Leechman, Esq.; E. T. Ayerst Hooker, Esq.; E. E. Pakeman, Esq.; Geo. E. Pearson, Esq., F.C.S.; G. M. Whiley, Esq.; J. D. Marshall, Esq.; Ernest J. Mitchell, Esq.; Edward Harrison, Esq.; A. J. Martin, Esq.; M. P. Shepherd, Esq., A.C.A.; Henry Cooke, Esq.; J. H. Evans-Jackson, Esq.; J. N. Evans-Jackson, Esq.; Wm. J. Tennant, Esq., M.I.M.E.; H. Wade, Esq.; Jacob Heilborn, Esq.; Geo. Kettle, Esq.; P. Blair Tayler, Esq.; Percy Izod, Esq.; E. H. Harberd, Esq.; J. H. Jack, Esq.; and J. E. Evans-Jackson, Esq. (*Hon. Secretary*).

position as anybody to learn the opinions of inventors generally, they are under the impression that it is an unfair thing to British inventors that a foreign inventor should come here and acquire a monopoly and not do what the British inventor in most cases has to do from the very nature of the subject, namely, work the invention. I think that we, as an Imperial Industries Club, ought to see to it that the British inventor is not, at any rate, worse off than the foreign inventor. He cannot in many cases at any rate,—in some he can, but in many cases he cannot—acquire foreign patents abroad in the same way that a foreigner can acquire a patent here, because there is compulsory working.

Now, no doubt some of those who will follow me may say that compulsory working is a mere matter of form and so on; but, if you have a powerful firm who insist upon that form and put the law in motion, then the British inventor who has a patent abroad may very likely lose that patent in some countries—not in all of them.

There are other points with regard to the working in this country that I think we as an Imperial Industries Club ought to consider. With regard, for instance, to munitions of war, on that deputation to Mr. Lloyd George we pointed out that at that particular time great industries were being founded by which the nitrogen of the atmosphere was being condensed, or concentrated as it were, into the essential material for the manufacture of smokeless powder. I particularly pointed that out. I said: Now there is an industry being created which, if it is not worked in this country, will leave us in time of war without the possibility of carrying on the work ourselves. An industry of that kind cannot be founded in a few weeks, and, consequently, unless the industries had been previously established in this country we should be in the position that if war broke out the saltpeter, which is an absolutely necessary ingredient for all explosives, would be contraband of war and we should not be able to obtain a supply, whereas our competitors, or our enemies perhaps, would be able to do so from the atmosphere. From establishing those industries they would be able to produce as much nitric acid as they required and we should be left without it. That, apparently, appealed to the Government at that time, and compulsory working was then established.

Now, it has not given us altogether what we want. I will not go into the legal argument. Mr. Justice Parker, whose name is a household word among inventors and well known in this room, has interpreted the law in a certain way. We had previously not interpreted it in that way. I do not propose to go into that, because my friend, Mr. Douglas Leechman, who is the Chairman of the Parliamentary Committee of our Institute, has made a special study of that, and if you wish he will give you chapter and verse for everything in connection with the legal aspect of the question. But what I wish to impress upon the members of this Club is that the matter is to some extent an Imperial one. It is one in which we ought to consider those of our kith and kin more, I think, than foreigners who come here, and whom we welcome, by the by. I would not for a moment say that we do not welcome them, for a very large number of our industries in Great Britain have been introduced and developed by foreigners, and I should be the very last one to say that we should not welcome foreigners in every way, but I do say this, that we ought not to give them a monopoly which can in any way injure our own people.

Now, as a consequence of that Act during the time when, if I may use the word, it was active, several firms abroad came and established factories in this country and (without again going into minute details which would probably be rather tedious to you, but I have a very considerable number of figures on that question) a number of factories have undoubtedly been established and industries have been established under the pressure of the Act as we interpreted it. It is not enough to say that one firm or another has put up a factory in England, and they are not doing much, that they have done it just simply as a blind, and so on; that is not so much the question; those who are behind the scenes know very well that a number of patents have been introduced into this country under royalty to British firms that would not otherwise have been introduced. When an industry is introduced into this country, whatever it may be, there is employment for British capital, there is employment for British workmen and the industry becomes established in this country and after the lapse of the patent the industry becomes an English one.

I would mention incidentally that the British Empire now is to some extent, I will not say in the melting pot, but we are going through troublous times with regard to the British Empire. We have self-governing Colonies, and the bond that links our self-governing Colonies to us is one of gossamer, and we can only keep together by the most careful interchange of opinions and of commercial interests especially. When I say that we have seven of the High Commissioners or the Agents-General of our self-governing Dominions as Members of the Institute of Inventors, I think you will see that we deal with the matter from the Imperial point of view, and that is particularly the point of view I should like to impress upon you this evening. There are a great number of things that one might mention that really cause an Englishman to blush because we are so dependent upon foreigners for things which are absolutely necessary for our existence as a nation. Of course, we know very well the history of the Whitehead torpedo. Our own Government would not take it up and it had to go to Austria to be started and then our Government bought it at an inflated price afterwards. That is a very well-known instance. I myself have had an instance. I started the industry of smokeless powder. I could not get our people to look at it here because they said the sights of all the rifles in the Army would have to be altered. The French did not look at it from that point of view quite; they saw a little bit further and they started the industry. Then our people came in afterwards, a second, perhaps a good second; but the less we say about cordite when it was first made I think the better. I think it a shame for Englishmen that they do not and our Government does not push ourselves to the forefront of nations. They can do it and why should they not? Then, again, you may not know it, but the glass required for optical purposes in our Army and Navy is German glass. For instance, the periscopes of the submarines are made from German glass. If we happened to have a war with Germany they would not give us their glasses.

MR. J. E. EVANS-JACKSON: That glass is not the subject of a patent.

MR. WALTER REID: Yes, I think so.

MR. J. E. EVANS-JACKSON: No, certainly not.

MR. WALTER REID: At any rate, any improvement upon it here would be to the advantage of this country. I happen to know something about that particular subject, because I am a member of a committee that studies this special subject; Sir William Crookes is also a member and we have very distinguished scientific men on it, and it struck us as being a great anomaly, and it struck me personally as being rather a shame that we should be dependent upon a foreign country for these things. If, as our genial Secretary says, there is no patent now at the present time, I would point out to him that the glass that was developed by Schott of Jena was developed financially and in every way only through the assistance of the German Government. Whether they give a money subvention for carrying out these experiments or whether they grant a patent, the whole thing is a development of the industry of the country, and if any foreigner were to come over here and were to get a patent monopoly for a new kind of glass he could hold up the whole industry if he liked in time of war. As a matter of fact, we are dependent for that glass upon the Germans, and that is the point I wish to make here: the Germans developed that industry through the assistance of their Government. There are many other things where our existence as a nation, I will not say is dependent upon, but may be, at any rate, interfered with.

I am reminded that the time is getting short for my opening remarks. I have a number of other matters, but I should like to refer just briefly to the commercial aspect of the question. The patents that are worked in this country may be of very great value indeed. If there are foreign patents which are not revoked or worked in this country they may stand in the way. I happen to be a director of a company that holds a very large number of patents; I think they are put down at about £140,000 in our balance sheet, and they are of considerable value from the point of view of master patents; they control a certain industry. If we had a foreigner come over here and get a patent that would stand in our way British capital would lose. It is a thing that affects commercial men even more than inventors.

Then, again, I would remark to you with regard to the working of a patent that it is extremely difficult—and this is a point with regard to which probably those who succeed me in speaking will say that the onus should lie upon the objector—to prove that a patentee does not work. That is a most difficult thing to prove. I know the legal gentlemen are in favor of that because that seems to be the general practice in the law, but it is not a practice without exception; there are many exceptions. I would point out here that it is almost impossible for a stranger to find out what is going on in any factory. We have an instance where a gentleman told us that he had tried for a year, he employed detectives and he found that the patent was worked; he found a tub in a kitchen; that was all he found and all he was able to find. If it is so difficult as to be almost impossible for an Englishman to find out what his foreign competitors are doing in this country, then I think the purpose of the Act will altogether fail. If the onus lies upon the objector to prove everything that the foreigner is doing I think it is quite impossible. With those few words I will conclude.

THE CHAIRMAN: I will ask Sir George Croydon Marks, M.P., to speak.

SIR GEORGE CROYDON MARKS, M.P.: *Mr. Chairman, my Lord, and Gentlemen*—I am very glad that our friend has wound up with a suggestion which I think gives the key to a great deal of the criticism which has come from that table. He speaks about being concerned with a company that has £140,000 written as the asset connected with patents, and he touches upon the financial side rather more strongly, I think, than he touches upon what I would call the commercial side. I, unfortunately, have had to deal with inventors and with manufacturers and engineers and others for a great many years, and I have not found that there is a disinclination upon anyone's part to improve their position or to improve their works, given a favorable opportunity. I have found, however, that in this country there is a lack of initiative, and a great deal of caution that one does not find in other countries. That goes a very long way to explain why some people succeed elsewhere, and others fail here. There are businesses in existence in this country which have failed, not because of foreign competition, and not because of foreign patents, but because the sons connected with the business that they found made for them by their fathers have not that initiative, have not that personal touch, and have not that knowledge that their fathers had to make the business. Hence it comes about that we find young men, who succeed to good commercial businesses, doing all that they can to show the people in the district in which they live that they belong to a different class from those poor manufacturers and the others; and if, perchance, they do happen to go to a works they just pass through it and pretend to have but a little acquaintance with the details; and is it any wonder that by and by the old-established firm finds it necessary to convert itself into a limited liability company in order that its declining trade may be bolstered up by capital caught from credulous people knowing nothing about the real decline; and then, when that business has failed, you have some of these prophets of woe coming along and suggesting: "We have lost our business owing to the wretched foreigners sending things here or patenting things here that we are not allowed to make"? I am perfectly certain that I could, within twenty minutes, satisfy any gentleman tomorrow morning that if you have some very good article here and you submit it to a number of old-fashioned firms, making them offers of it, they will turn that down straight away, and say they have no need for it; they have all the skill that they want in connection with their own firm; and if they cannot produce what is wanted then that which we offer them is no good at all.

Our friend spoke just now about the terrible things that are going to happen if, perchance, some patent connected with munitions of war happens to be held by a foreigner when war breaks out. Well, if we have to make up our minds that we have to depend upon that which we can do in these Isles, only upon that which we ourselves can construct and bring about, we have to look to something a little bit broader than patents: we have to look to food; because the same suggestion about starving a nation out could be quite as readily made as killing our industries by working us out. I know from my own personal knowledge a firm in America who have supplied the British Admiralty and the British War Office with things used on the British guns; and I have seen cheques today to the extent of over £1,200 in connection with these things used during the last six months on British guns supplied from America, and there is not a single British firm connected with munitions of war that will take the patent up or be bothered about it when they have been approached. I could show our friends tomorrow letters from large firms whose attention has been called to these particular things; they mark it "secret" when they examine it, and then they send and tell you they do not need it. Why? It would be a reflection upon some member of their staff if they recognized that a person outside of that staff could do anything better than is there being done, and therefore it is refused. No, Gentlemen, you have to get a little nearer if you want to find the reason for some of the decline of our industries. You have to get a pride in industry as much as a pride in position: you have to make people as satisfied to be concerned in a manufacturing industry as they are to be concerned, say, with the profession of law or with the profession of medicine: they have to be as zealous in their work, and as eager to develop there as their fathers were if they are to hold the trade. The trades that exist today that were formed by good men years ago are only continued today very often by new blood having been brought in, owing to the sons having shown a disinclination to carry on the business; they take their money and clear out. I could give one illustration from Birmingham: the firm, who were fathers of the whole industry of the civilized world in connection with mechanical power, was that of Boulton and Watt, and yet their works in Birmingham were subsequently acquired and became works, not for the great engineering industry, but for the manufacture of scales, and so are used today; while the works on the adjoining piece of ground, employing about 3,000 men, was formed within the last forty years into the great world-wide engineering business of Tangye's, Limited, by four men, two of whom are still alive today. Those men formed an industry and developed it, not solely by their patents, but by their zeal and by their personal industry. The other firm, that had the world at its feet, let the thing go, because those who were to succeed them had not that personal pride and initiative in that which they were doing.

Patents cannot be put upon the same footing as ordinary articles. A patent is a monopoly, and to talk about free trade in patents is to put one opposite against another. The real remedy for the trouble in connection with the abuse of patents is that, if a patentee does not work it in this country after, say, four or five years, it should be automatically open to people in the trade, who desire to work it, to go to the Patent Office and require a license to be given on reasonable terms—in order that they should work that patent; and then by so working it they would develop and bring from abroad that skill which would enable them to improve that which was originally initiated from abroad.

When the Patent Act of 1907 was being discussed in Parliament I fought it every line in connection with the compulsory working proposals. I pointed out then that the people who were clamoring for it did not know what they were clamoring for—and by and by they would be sadly disappointed, as they have been. I pointed out that they were not aware of the difficulties that inventors had to get their inventions adopted—and I was considered to be a man who was only professionally interested in these things; but, unfortunately, since then inventors and others have found out that this wonderful Act, which was going to bring about such a large amount of extra work for them, has disappointed them, and it has not only disappointed them, but it has disappointed the public to some extent. That Act of 1907 had marvelously good points in connection with it quite outside the compulsory working and quite outside those things connected with that part of the subject that we are now discussing, but those points have been largely overlooked. It was a new charter which was given to the same people who clamored a few years ago under the idea that if they stamped every article when it came into this country with the name of the country from which it came then that would make people demand English things, if they happened to see "Germany" marked on it or "Belgium" marked on it. Those people were then known by some of us to be deluded people and working for a "Will o' the wisp." They got the "Will o' the wisp," and, they did not burn their fingers or get any light, but after they had apparently got it they looked for it, and found it was not there; but what was there all the time was a departing trade that the foreigners had captured owing to the immense advertisement that we had given them by requiring that stamp upon the goods "Made in Germany;" thus making people, when they wanted a cheap article, say: We must go to Germany for it; England cannot possibly do it.

No, Gentlemen, we made a big mistake when we introduced into that Act of 1907 the compulsory working—a very big mistake, as the whole industry now recognizes. The "Inventors' Institute," I am glad to find, recognizes it; I am very glad to find that the commercial people recognize it and I would ask them now to direct their attention to getting a reform, not in the matter of compulsory working, but of automatic licenses, so that if a man does not work it, you can go and demand that you may work it. And if you demand that you shall work it he will then be obliged to come forward to prove that he is already properly commercially working it. That will be a very easy way of getting what our friends there desire, the proof that it is being actually worked, and the opportunity to work it, if the other man is not doing it.

Gentlemen, I have run past my time; but I am very glad to have had the opportunity of speaking. As one who was concerned with that 1907 Patent Act, who was on the committee when it was being discussed, who was present when Mr. Lloyd George received the deputation to which our friend referred, I am glad to be able to point out that that which was then originally declared by me as being something which would be bound ultimately to bring disappointment, has brought disappointment; and tonight here we must remedy it by going on a new path altogether.

THE CHAIRMAN: I am now allowed to call upon Mr. Alexander Siemens to speak to you.

MR. ALEXANDER SIEMENS: *Mr. President and Gentlemen*—What I think about the working of patents I said in a lecture before the Society of Arts some time ago, when I had this honor, that Lord Alverstone was in the Chair and Lord Moulton criticized. I will say at once that both those gentlemen sat upon me and flattened me out. They said I was absolutely wrong. Now I want, all the same, to repeat what I said then. First, I wish to back up Mr. Walter Reid in his statement that the Act of Monopolies originally made an exception in favor of those people who introduced a new industry into England; and I want to protest against giving the dog a bad name and calling it compulsory working. It is not compulsory working. Now, to make my reasoning clear, who is an inventor and what is inventing? According to my notion a man who wishes to improve processes which are in use ought to have a perfect knowledge of the natural laws referring to the subject. He ought to know what has been done before, and especially he ought to know the endeavors to improve some methods which have failed, because you learn more through failures than through successes. I will put everything very shortly, but you know perfectly well what I mean. And he ought also to know what is the demand; in what direction ought improvements to be made.

Now, what I contend is that the inventor, so-called, who is represented in the novels and children's books as going to bed one evening—quite sober, of course—having a lucid idea during the night and getting up the next morning a saviour of society, or a benefactor of his fatherland, and all that sort of thing, does not exist. As I have said already, the people who really can propose improvements which are worth having are those who have to do with the things all the time, who know what they are about and—I am coming presently to a point which displeased Lord Moulton very much—I think it is the manufacturers themselves who know best where the improvements ought to come in, and how to make experiments and conduct their researches in order to effect their purpose. The outsiders have no idea. It is, of course, always a story that medical men were the greatest electricians; look at Volta and Helmholtz, and goodness knows how many more; but if you come to look into it, take the medical profession, they devoted themselves entirely to electricity (I am just taking that example), and, of course, they were capable of suggesting the proper improvements. Now, the outsiders come with all sorts of rubbishy inventions, and it is almost impossible to convince some of them. In that respect, I would only retail to you a saying of Sir William Siemens. He used to say: "I have an appointment with an inventor this afternoon; that means I shall waste two hours of my valuable time, and I shall make an enemy for life" because no inventor ever believes that he is wrong. On the other hand, I want to go a little further about this compulsory working, or putting the thing into practical use. I want to protect the inventor in this way, that if he has introduced his invention so that it is used on a commercial scale, then it shall not be possible to upset the patent by anything but proving that the same thing had been commercially done before and that is really the point. I am sure you are all well acquainted with patents which are fishing patents, which put something, for instance, about wireless. Wireless is in the air: somebody puts down a sort of provisional specification with all sorts of notions, and then he looks afterwards into complete specifications which are dated perhaps later than his own provisional, and when he files his final specification he embodies all sorts of things which he has picked up in the meantime. That such a man should be protected is wrong, and it is really only the practical introduction of an idea (an expression which I prefer to use to compulsory working) which should protect it. If you like to suggest any topic to me whatever, I will suggest at once a patentable idea to improve it, but whether it will work is another matter, and that is the essential matter. If a novel idea really shows by practical introduction that it is worth having, then it deserves protection, but the mere stating of a novel idea is no good whatever. In support of that statement I would ask you: Do you know many inventions which are worked in accordance with their specifications? I think those of you who are practical people will know that there is hardly any invention which is worked as stated in the final specification. There are always practical modifications, modifications of detail as they call it, but it is the details which are the essential things, and which prove whether the thing is practicable or not, and therefore the working of an idea is the essential thing, and not merely stating something which is beautiful to look at.

THE CHAIRMAN: We are now to have the pleasure of hearing Mr. Oliver Imray, ex-President of the Chartered Institute of Patent Agents.

MR. OLIVER IMRAY: *Mr. Chairman, my Lord, and Gentlemen*—A good many of my views have already been expressed by Sir George Croydon Marks. I fully endorse everything that he says.

Gentlemen, what we have to consider is: What is a patent? A patent is a monopoly; and without the grant of a monopoly of some kind you cannot expect any capitalist, any manufacturer, to introduce a new invention into this country. He must have some sort of protection so that if he puts capital into a patent he is going to have the monopoly for a certain period. Now, Gentlemen, the monopoly granted to a patentee is absolutely absurd as compared with that granted to the author of a book. Further, Gentlemen, a patent can be attacked, first of all on disconformity between the provisional specification and complete specification, on novelty, either prior publication or prior user, on the question of subject matter, on the question as to whether the specification properly describes the invention—there are four or five grounds on which a patent can be attacked. Compulsory working introduces a further ground upon which to attack that patent.

Now, Gentlemen, if you come to think of it, there are 100,000 patents in force, in existence, at any time you like to mention. I have taken out the statistics. I know it for a fact. There are 100,000 patents. What has been the result of the 1907 Act? To take an average, there have been five patents a year revoked on the ground of non-working. For the sake of those five patents a year, you introduce an additional clause for revocation of a patent, or for attacking the validity of it. Is it worth while doing that? I say it is distinctly not. Gentlemen, are inventors to be encouraged? They not only produce an income of over £100,000 a year to the Revenue, but they supply employment for the Patent Office and its officials to the amount of £150,000 a year. Surely you ought to consider an inventor, and do the best you can for him! I have had thirty-five or forty years' experience of, not only the working clauses of this country, but the working clauses all over the world, and I say the compulsory working is a great farce, absolutely. You can always get outside of it.

Now, Gentlemen, I agree that compulsory working to the general public is an absolutely ideal measure. It is supposed to introduce inventions into this country, and to encourage the employment of labor. That is true enough, but the result of compulsory working from my experience, and from the first few actions brought for revocation, was not to introduce the industry into this country, but to revoke the patent, and allow Germans and Belgians, and French people, to dump their goods in this country.

Gentlemen, I hope, if any other legislation takes place, it shall not make the compulsory working clause more drastic, but shall amend it in this sense: that before a person can apply for revocation of a patent on the ground of non-working he should in the first instance say that he has applied for a license, and it has been refused—that is a very good ground; and not only that, but that he is prepared to actually manufacture in this country if the patent be revoked.

THE CHAIRMAN: I will now call upon Mr. A. J. Walter, K.C.

MR. A. J. WALTER, K.C.: *Mr. Chairman, my Lord Moulton, and Gentlemen*—The motion which I apprehend we are gathered here tonight to discuss is the proposal made by the Manchester Chamber of Commerce to the effect that the Association urges upon His Majesty's Government to amend the Rules under the Act of 1907 in such terms as will place the burden of proof of working in this country upon the patentee. A more mischievous resolution I have never had the opportunity of seeing.

What is the meaning of a patent? It is that reward which every State has found it necessary to institute in order to encourage invention. Various countries, Belgium and Switzerland among others, decided that they would have no monopolies. They found that invention dropped off at once, because there was no incentive to inventors to employ their inventive faculty. Compulsory working is dictated by nothing else than the desire of others to destroy the monopoly which the State has given to the man who has made the invention and to enjoy the fruits of that invention. Compulsory working has been suggested purely and simply by the desire to appropriate the brains of others, by persons who have not the intelligence to invent themselves. It is the destruction of the very right which the State has given to the man as a reward for his having exercized inventive faculties.

I have had, perhaps, more experience than anyone in this room of the class of persons who present petitions for the revocation of Letters Patent. I have known no case where petitions have been presented by persons who desired to work the invention in this country. Petitions are always presented by persons who have in some instances initiated manufacture abroad in order to come and present a petition to the Courts of this country so that they may say that there is a greater working abroad than there is in this country, in order, as has been graphically and euphemistically described by an earlier speaker, that they may dump their goods in this country; and I know of no *bona fide* petition presented by any person in this realm for the revocation of Letters Patent for the purpose of encouraging manufacture in this country; but, on the other hand, all petitions have been presented for the purpose of encouraging manufacture abroad, and destroying manufacture in this country.

I am, to a certain extent, with the motion in the sense that a patent is essentially a territorial monopoly presented by the Government of a country to an inventor who has benefited the country by making an invention for which they have granted him the patent, and who, if he is a *bona fide* inventor in the realm, will work that invention without any legislation of any kind or description. My experience is that if a man has an invention that is worth working there are very few commercial people who in time will not ascertain its value and assist him in working it without any legislation of any kind. If it is not worked it is for one of two reasons: either that it is valueless, and therefore had better be left alone, or else that the patent has been obtained by a person not domiciled in this country for the purpose of preventing working in this country, and manufacturing abroad, and importing into this country. I should draw a broad distinction myself in the case of inventors of other countries who take out patents in this country, not to benefit this country, but in order to dump their goods here, and prevent anybody manufacturing in this country. That is one class of harmful monopoly at which undoubtedly legislation might properly be aimed. I would apply that equally to English inventors in foreign countries. If any inventor takes out protection in countries other than his own in order to stop people in those countries working inventions, I would devise measures to see, as Sir George Marks said, that he shall be compelled to grant licenses; but in the case of the inventor in this country who is working in this country, and who has not taken out patents in other countries, or, even if he has taken out patents, is not able to work them there, I would not allow him—as the law at present is—to be liable to have set up against his volume of trade in England the volume of trade in the patented article all over the world, over which manufacture he has no control whatever, and probably knows nothing about—to be put in the pillory to answer questions as to whether or not the manufacture in this country is greater than the manufacture abroad. That is the law in this country on the interpretation of the Act of 1907, a position which I venture to think no sane person can ever have contemplated in Parliament, though the words of it undoubtedly do imply so. Lord Parker held, under the terms of the Act of 1907, that a patentee in this country, having only a patent in this country, could have a petition presented against him for revocation of the Letters Patent if the manufacture abroad, which he neither controlled nor had anything to do with, was greater than the manufacture in this country. I say that to put a patentee in such a position is absolutely unjust. (MR. J. E. EVANS-JACKSON: "Monstrous.")

I have no objection, personally, to a system which would compel a person who takes out any territorial monopoly, the territory being that in which he is not domiciled, to grant licenses, as Sir George Marks says. Supposing a German takes out a patent in his own country and in this country, and does not work the patent in this country at all, but uses England as a dumping ground I should compel him to grant licenses. Similarly, I would compel an Englishman who works in this country, and takes out a patent in Germany, and does not work there, but dumps his goods into Germany, to grant licenses in Germany.

What is the present position of compulsory licenses? It has been my privilege, I think, to be in every compulsory license case which has come before the Courts since the Act of 1888, and what has been my experience with regard to those? There has been no *bona fide* petition presented. It has always been the desire of the "Have-nots" to share in the benefits of the "Haves." Take the great monopolies of recent years: the Dunlop and the Welsbach, where there were huge industries introduced by reason of the patent monopoly granted. In every case the petitions presented against those companies were by persons who made fictitious improvements, not of any value whatever, and who then applied for licenses to work the monopolies of the Dunlop Company and the Welsbach Company. Is that the sort of way in which inventors are encouraged by a country to exercise invention? The conditions under which compulsory licenses are granted should be entirely altered from those which exist at present; and all those persons whom I call the "Have-nots," who desire to share in the blessings of the "Haves," should be by rules prevented from troubling patentees with their desire to reap where they have not sown.

Personally, I object to the whole of this grandmotherly legislation. It is grandmotherly. Commerce will look after itself, and if inventions are worth anything they will be worked, and the industrial members of the community will look after them. It is no good quoting as Mr. Alexander Siemens did, a remark of his great ancestor: "that most inventors wasted a couple of hours of his time." It is quite true that there are so-called inventors of that type; but a man of the ability of anyone of the name of Siemens would in five minutes recognize whether he was dealing with a crank or whether he was dealing with a man who had goods to sell, and if he found that he had got goods to sell, and they were goods in which he dealt, he would very readily make a bargain and deal in them. On the whole, therefore, though, as I say, I do not oppose anything which would prevent patents being used by citizens of other countries to stop working in this country and to assist the dumping of their goods in our country, I think that the whole legislation, both with regard to compulsory licenses and with regard to compulsory working, is a hindrance to trade, and a hindrance to invention, and should be abolished *in toto*.

THE CHAIRMAN: I will now call upon Mr. Douglas Leechman.

MR. DOUGLAS LEECHMAN: *Mr. President, my Lord, and Gentlemen*—So much has been already said that I wanted to say that I shall not trouble you very long. I take it that the object of this Club is to promote the industries of the country, and we will all admit industries are very largely founded upon inventions. Inventions, therefore, should be encouraged, and they should be encouraged in the form of granting Letters Patent, and the Letters Patent should be worked in this country as much as possible. I think everybody wants to see inventions carried into practice and not merely left on paper. Further than that, the patent when granted should be maintained if possible. In that connection I should like to say right away that you are not going to encourage trade or invention or patentees by saying, "Either work your patent or lose it." If you are going to get the benefit out of the inventions that are made by the patentees you must preserve the patents and not hold a pistol at a man's head and say, "Work it or die," because nobody wants, or I will not say nobody, but in very few cases do manufacturers care to take up an invention for which they will have no protection. If a man is to take up a new thing he wants to have some privilege in connection with it.

Now, I should like just to echo Mr. Imray's reference to the extracting of £100,000 a year from poor inventors by the Patent Office. I do think that the Government are not quite doing their duty to inventors in that connection. If they want to encourage the poor inventor, as the present Patent Act is supposed to do, they ought not to say, "You shall pay 9d. for 4d."

Mr. A. J. Walter, K.C., has so amply dealt with the result of these petitions for revocation that I need not dwell upon that subject; but these petitions do not go to promote industry in this country; they throw the invention open to everybody if the petition is granted; and, as I have already said, that does not promote our trade.

Now, the working of inventions should be promoted, and to that extent I am in favor of compulsory working, but not in the form of threatening a man with revocation. If you want to insist upon an invention being worked you should make the inventor grant a license, if he will not work it, or cannot work it himself. The patentee is not a dog in the manger. There may be a very few patentees who are dogs in the manger, but theirs is not a typical case. If I may echo what Sir George Croydon Marks has said, the dog in the manger is the manufacturer. He says, "I do not believe that you have anything better than I have got, but even if you have, I am not going to look at it." He feels that his sense of dignity is lowered if he takes up an outside invention.

What I would advocate would be the simplification of the grant of compulsory licenses. At present we have this extraordinary position. The Comptroller-General will forgive me for likening him to a magistrate. At present the position is that the magistrate may pass the death sentence in the form of revocation; but if you want to commit a man for six months, or whatever the period of the license is, you have to go to a Judge of the High Court. I would like to make compulsory licenses as easily obtained as compulsory working is at the present time. One should file an application with the Comptroller, and he should be able to deal with it. The reason why compulsory licenses have not been popular in the past has probably been because of the difficulty of working the machinery. I should like to see Sections 24 and 27, those relating to compulsory licenses and compulsory working, amalgamated. One should give the control of the matter to the Comptroller-General, and revocation might come in as a possible alternative. That is to say, if a man refused to grant a license on reasonable terms, then he should be told, "Very well, then you shall lose your patent altogether."

Finally, I should like to say how thoroughly I disapprove of the idea of throwing the onus of proving the "main" and "extensive" and "adequate" and "satisfactory" working in this country upon the patentee, upon the mere allegation of the applicant for revocation to the contrary. If an applicant has not got enough information to make out a *prima facie* case to support his application, then it is not worth much.

THE CHAIRMAN: Mr. H. A. Colefax, K.C., will now kindly speak to us.

MR. H. A. COLEFAX, K.C.: *Mr. Chairman, Lord Moulton, and Gentlemen*—I should like at the outset to express my appreciation of the kindness you have done me in inviting me here this evening. When I received the invitation I was acquainted at the same time with the fact that it was proposed that this question of Compulsory Working should be discussed here tonight. I confess I was a little surprised; because it seemed to me rather as if to discuss that question was an unwarranted interference with what I had regarded as the certain but slow death of an unsatisfactory statutory enactment. However, I discover that in that conclusion I was wrong, because I did not know at the time what I know now, that the Manchester Chamber of Commerce is apparently still on the war path. We know that in large measure the Manchester Chamber of Commerce was responsible for this provision in our statute law that we are discussing tonight. See what it is that they are proposing now. They have got their enactment, and surely, from the standpoint of cheapness and ease with which anyone can come forward and claim on this ground that a patent should be revoked, the provisions in force I should have thought left nothing to be desired; but, apparently, they do not satisfy the Manchester Chamber of Commerce, and they are asking now that there should be an alteration in the rules; and that alteration, I think, we can put quite shortly in this way. They are proposing that when the plaintiff has put forward his case, not proved it, but merely alleged it, then the defendant, the patentee, should be called upon to disprove that case. Well, I venture to think that that is really an unheard-of proposition and would be a gross injustice to patentees in this country and more particularly when one thinks for a moment what is the position under these provisions. We have heard a great deal lately of the common informer, and I cannot help thinking that these provisions which are in force today do really put into the hands of a man, who need be nothing more than a common informer, a right to come to the Patent Office and demand the revocation of the patent. Now, I think it was Mr. Reid at the outset of our proceedings tonight who suggested that these provisions had as their object to give more employment in this country. I do not think that is correct. I remember one of the very earliest cases, and I have been engaged in a good many of them, and I dare mention this case, because although the Comptroller is present, it was not his decision, but the decision of his predecessor. It was a case of this character. There was a patent here for a certain invention, and by an oversight no patent had been applied for in Germany. There was no question that the patent could have been obtained, but by an oversight it had not been applied for. The applicant for the revocation of that patent was a foreigner, who did, I believe, a commission business in the City of London; and his object in applying for revocation was not in any way to give employment in this country except to himself. But what he did seek to do by revoking the British patent was that he might be able to import a German-made machine into this country and so sell it freely. That is one of the very first cases that I remember under this Act.

Something has been said also, I think it was by Mr. Reid, about Imperial unity. I confess that that is a subject that I feel strongly about myself and in every way desire to further. But it does not seem to me that these provisions in any way make for that, because, unless I am mistaken, our Colonies have copied our Act in so far as they have altered their legislation since the 1907 Act has been passed, and in several instances have incorporated into their Statute law provisions exactly similar to those which we have in force in this country; and therefore so far as Imperial unity is concerned it seems to me that it rather makes away from than in favor of that valuable objective.

Now, upon this question I, personally, have not a shadow of doubt. I have had a good deal of experience, and I am absolutely convinced that at present there is no countervailing advantage obtained under these provisions. The path of an inventor is beset with very considerable difficulties and every one of us who has to work in connection with patents, and deal with this question, knows the enormous pitfalls there are in the way of a man who has made an invention obtaining with certainty valid protection for that invention and I venture to think that he ought not to be saddled with these provisions unless it is absolutely clear that there are paramount countervailing advantages, and of those at present I know of no evidence.

One aspect of this question has not been alluded to tonight, and I should like just to mention it, because you will remember that under the Act it is not only possible to apply to the Patent Office for revocation, or by petition to apply to the Courts for revocation, but it is also possible for a defendant to raise by way of defense a plea that the invention the subject of the patent has not been worked in this country. I do not know how many times that defense has been raised, but it is within my own knowledge that it has been raised a great many times. One case I remember in which it was raised—I could cite more than one, but one occurs to me just now, namely, the Vidal Dyes Syndicate *vs.* Levinstein. It is germane to what we are discussing tonight. What happened there is what I think has happened in every case. The defendant was raising among other defenses, that the invention would not give any useful result at all. Well, he very soon found himself in this curious position, that in urging that it had not been worked to an adequate extent in this country as compared with abroad, he was relying upon a defense which conflicted with the plea that the invention could not lead to any useful result. There are many other cases; but I believe that in no single case up to now has that defense ever been presented to a Judge for his consideration or his judgment. So far as the application to the Patent Office is concerned, I, personally, join with what has been said by more than one speaker tonight, and that is this, that this procedure is not a wise one, and if in truth what you want to do is to make it so that a man who is enjoying the monopoly of an invention should either himself put in operation in this country his invention, or that otherwise it should be put into operation, then I feel myself most strongly that the proper and fair course is to alter, if not satisfactory at present, the procedure for compulsory licenses and that by a compulsory license you have the right way to attain that end.

Now, there are only one or two other matters I would just mention before I sit down. Something has been said by my learned friend, Mr. Walter here, about the decision of Lord Parker. I am not questioning its soundness from the standpoint of a legal decision, but I confess that if these provisions are to stand, and that decision is to stand, there is something very wrong in the application of the Act, because I cannot believe myself that it was ever intended that you should on the one hand look at the extent of manufacture abroad and contrast that with the extent of manufacture here, when all the time the poor unfortunate patentee here may have absolutely no control whatever over the manufacture abroad. Surely, if you are going in any way to endeavor to apply such provisions as these, they ought to be provisions applicable only under these conditions, that what is contrasted is the sale of the article, whether imported or otherwise, in this country, with the extent of manufacture abroad, and nothing beyond that. It is quite true that the patentee at the moment has an offset to that position as decided by Lord Parker, in that he may include among the working in this country the infringing working, which also has always seemed to me a somewhat curious decision. At any rate that is the position of affairs.

Well, Gentlemen, so much has been said upon this that I do not believe I can usefully add more; but I would join with those who take up the standpoint that if we are anxious to see that an invention enjoying a monopoly in this country should be worked here the proper course is by compulsory license, and not by these provisions as to compulsory working.

THE CHAIRMAN: Gentlemen, you will have noticed with very great pleasure, I know, the presence among us of the Right Honourable Lord Moulton. We are very grateful to His Lordship for coming here this evening, and I am grateful to him, and so will you be, that he has consented to address us.

THE RIGHT HON. LORD MOULTON OF BANK, P.C., F.R.S.: *Mr. Chairman and Gentlemen*—I have enjoyed these speeches very much, but there has been a tinge of regret. There was a time when I could have made just as fiery a speech as Mr. Walter and, in fact, there was a little in the swing of his sentences which made me think that perhaps I had not been wholly strange to his education in that matter. But you see I am a tennis player turned umpire, and I have grown to look at strokes with a very much cooler head than I used to in those days when I played, and I have been trying, while this very interesting debate has gone on, to keep myself in the attitude of mind that one tries to keep one's self in when one hears a case: you hear the arguments on both sides and then you give your judgment. It does not follow that your judgment will not be strong. It is quite possible that the case may be so good, or so bad, that you not only use verbs and nouns, but you also use adjectives.

Well, Gentlemen, so far as the legislation as it stands, about compulsory working is concerned, I am afraid I am going to use adjectives. I think it is not only mischievous, it is also idiotic. It is one of those cases which are growing to be common, where the layman rushes into legislation with little or no acquaintance with the subject on which he is legislating. Knowledge has gone so far that the layman cannot keep up with the technical knowledge of a subject, even in politics. In my opinion, it would have been impossible for any man who understood this matter to devise the present legislation.

Now, let us take one example, and remember when you are testing whether a thing is right or wrong by an example, you must never take an extreme example; you must take one which fairly represents it. Let me suppose that a man makes an invention and contents himself by taking out an English patent. The invention turns out to be of world-wide utility; it is adopted, we will say, by every civilized nation in the world: but the inventor has no rights abroad: he has rights in England only. Then comes some person and says, "Your patent is worked mainly abroad." Of course it is. Big as England is, the world outside is bigger. Then he appeals to this legislation, and claims that the patent must be revoked because it is worked mainly abroad. In this he is justified and the consequence is that an invention that is universally valuable and universally appreciated stands in the eye of the legislation of England, as it at present exists, as condemned to death, and it will be revoked unless the poor inventor can explain how it is that a useful thing is used more abroad than it is in England.

It is no use arguing about legislation of that kind. It is self-condemned. We should be wasting our time here, if we discussed whether it should or should not be altered. Accordingly, I prefer to utilize the time in considering what is the real mischief that has driven people to such extravagant and ill-judged legislation. I do not hesitate to say that the very able Minister who fathered that Bill and got it through the House of Commons literally saw red when the word inventor was mentioned. He looked upon this poor harmless set of people as wolves ravening on the unhappy British public. And he apparently is not the only person who does so. I have heard here the representative of a great name quoting the authority of one of the greatest members of his family to the effect that whenever he met an inventor it meant two wasted hours and the making of an enemy. He is quite wrong. I could mention an inventor whom I very often saw, and sometimes was lucky enough to have two hours with. But I neither made an enemy nor wasted my time, for that inventor's name was Sir William Siemens.

MR. ALEXANDER SIEMENS: You are not a manufacturer.

LORD MOULTON: I have seen many inventors, and so many of them are people whose lives are almost eaten up by the idea that they are trying to nourish into usefulness and strength, and I think that if I had one of them before me, and he did not know anything about the legislation as to patents, and I told him, "You know that now they have passed a law for the compulsory working of inventions," he would have said, "Oh, thank God, that is all I want" because he would firmly believe that his idea was such that if it was only worked he would prosper. Such compulsory working of inventions would be the greatest possible boon for an inventor, but the present law as to compulsory working is well-nigh fatal to the chances of remuneration which he would otherwise have. It punishes him for want of success which is not due to his fault. I challenge anyone of those here present, whatever view he takes of this subject, to answer me this question. Did you ever know an inventor (who was not also a manufacturer) who was not eager to have his invention worked everywhere? The mischief that has stirred up people to pass this legislation is that manufacturers, not inventors, stop the use of inventions in this country. Just think of the cases. Do you think that a man who invents a new dye would not like it to be made by Mr. Levinstein as well as everybody else. But it is a different question when a great foreign firm gets it. They do not want to protect the inventor's rights. They want to protect the manufacturer's rights. The consequence is that the whole cause of the outcry is the manufacturer who wants to get a monopoly by means of the rights which we have given to the inventor as a reward for his original thought, and you never find any mischief of the kind that it is supposed we must guard against as long as the patent remains in the inventor's hands. I smile when I hear those who take the opposite side in this controversy talk about the advantage of compulsory working because it brings trade into England and gives work to our working class. Mr. Levinstein is an old friend and an old client of mine, but do you think he conducts his campaign in order to bring the Badische Anilin und Soda Fabrik into England? No, no, no. If you strip the cases of the formal language in which they are put, you will always find that the man who wants to revoke a patent is a manufacturer who wants to prevent the inventor proper from getting the return of his invention. I have said that I never knew any inventor, who kept the interest in his invention in his own hands, who was ever unwilling that it should be worked as largely as possible in every country in the world. Occasionally you may find a crank who puts too high a value on his invention, and will let the few years of the patent pass and his invention remain unused, simply because he thinks that the royalties offered are too low, but those cases are so rare that they may be neglected. No, the applications to revoke patents are not for the purpose of increasing the manufacture in England; they are for the purpose of increasing the importation into England. It is this which makes it so important to give to people clear ideas on the subject. As you know, it is quite possible that the specious appearance of a movement in favor of English manufacturers (and it can be clad in those words) may bring some attempt to increase the severity of the law. This can be resisted only by showing to the world, first of all, that the movement is always from the manufacturer—the inventor has no interest in limiting the use of his patent—and, secondly, that the aim of all these attempts is to increase importation into England, and not manufacture in England.

So much for the real substance of the case. What then is the true remedy? The true remedy is that you ought to protect the monopoly of every inventor who behaves reasonably and punish those only who act unreasonably. If an inventor sells his rights to a foreign manufacturer, and that foreign manufacturer uses the English patent to prevent manufacture in England, a manufacturer who is willing to make the article in England ought to be able to get a license to do it. No patent ought to be used for the purpose of checking work in the country itself. But let me point out the dangers that there are in taking a principle like that and using it without knowledge and without caution. There are many things that are best manufactured by one or two firms. The demand is small for them, and one or two firms can well satisfy it. If you threw it open to hundreds of firms you would get no greater benefit to the country. (A voice: "Less.") Therefore we have adopted the rule, and I think it is a wise one, that the inventor should be left to manage his own patent, fix his own royalties, and get as much from it as he can with his own personal knowledge of the matter. But if he acts so unreasonably that the patent is having the effect of seriously checking working in England, then give the power to the Courts to grant a compulsory license. That is remedy enough, and I should counsel you not to do anything else whatever. If you do you will find that all you are doing is to help people to take the ideas of the inventor without giving any fair return, and to help people who manufacture abroad to import their goods into this country without remunerating the inventor. We do not want to see that, because we desire to see English manufactures increase, for we feel that we have a growing working population. We are glad to welcome new industries to develop in our midst; but, if we try to bring that about by unjust laws, you may be perfectly certain you will do more harm than good, and ultimately you will regret it.

MR. ALEXANDER SIEMENS: Mr. Chairman, may I say one word about what Lord Moulton said with reference to my remarks about Sir William Siemens? Sir William Siemens was interviewed by an inventor, who wanted him to pay him money, but when Sir William Siemens interviewed Mr. Fletcher Moulton, as he was at that time, he was consulting a barrister.

THE CHAIRMAN: It is interesting that the next name on my list is that of the Hon. Hugh Fletcher Moulton, and I will ask him to address us.

THE HON. HUGH FLETCHER MOULTON: *Mr. Chairman and Gentlemen*—The Chairman's conduct explains something for which the reason at first was not obvious and that is why it was not he but somebody else who was called on to say grace. Obviously, this was on account of his lack of scriptural knowledge, for there are certain things which you learn in the Scriptures and one is: Do not first place your old wine before your guests and then the new, because truly they will say the old is better. I very strongly object to the order in which the members of my family have been called on.

With regard to the subject of the debate I will say this: the whole of my natural instincts are in favor of compulsory working. On the other hand, the whole of my trade knowledge shows me how useless it is.

Now I have a great deal of sympathy with the principle of introducing working in England, but I do feel that with regard to the means for accomplishing this we shall find again that the old is better. The old idea of introducing a new manufacture was to give it a monopoly, to protect it from competition. I am a believer in Free Trade; I am a believer in the principle that it is a good thing to give a healthy baby a cold bath; but I am not a believer in the principle of exposing a baby, who has been judicially found to be in a weakly state, under Niagara, and it seems to me that, when you find a manufacture is being wholly or mainly practised abroad, to say that the best way of introducing it into England is to destroy the protection of monopoly, is an utter fallacy.

The gentleman who opened this debate has appealed to the Colonies. I also appeal to the Colonies, and I say we might very well follow them. Take the case of Australia. In the case of Australia they did not wholly reject the assistance of men who knew something about the Patent Law. There is a gentleman present here tonight who had a great deal to do with the drafting of the Australian clause. And what did they draft? They drafted a law which provided that in the case where a patent was not sufficiently worked there you could get a compulsory license. That ought to be the principle here. That enables the manufacture to be introduced here under the protection of a monopoly. Even in an extreme case, if you wanted to say to the patentee that he is to forfeit his whole right, I should say that he ought to forfeit it to the Crown and that the Crown should keep the monopoly and grant licenses to British manufacturers rather than to say: This industry is established abroad and we are going to abolish all possibility of introducing it here under the protection of a monopoly.

There is one thing we have been discussing, *viz.*, the proposals of the Manchester Chamber of Commerce, and nobody has ventured, perhaps in courtesy to the opener and to those who support him, to refer to the provisions of the Bill prepared by them. I propose to break through that convention. This new change is supposed to be in the interests of business men. I wonder how many people here have read the Bill which the Manchester Chamber of Commerce wish to introduce. (MR. J. E. EVANS-JACKSON: "Not one.") One of the proposals is, that if anyone has a patent, a common informer can come forward and say, "I believe this is being worked more abroad than it is in this country; I call upon the firm to produce the whole of its books and demonstrate to us that it is not"—a pleasant prospect for a really business firm. Here is another of the proposals: Any contract in reference to any patented article is to be filed with the Attorney-General for publication. I wonder how many business firms would have supported that provision if for one moment they had understood what it meant? I do not want to be severe on our friends here, but I do feel that we have a duty to the business community and one of those duties is to protect it from its so-called friends. Now, Gentlemen, time is nearly up, but there is one thing for which I am going to thank the opener from a purely personal point of view, and that is, for referring to the glass industry in Germany. Why I am glad he referred to it is because it refers to a project which is very near my own heart and because there are at least two members of the London County Council here. Anybody who knows anything about why the German glass industry is so prosperous knows that it is because of the munificent sums which have been spent in Jena in cultivating research in optical glass. For some ten years that same project has been before the County Council in London, and I ask our friend, Mr. Urquhart Fisher, to weigh those remarks and see that they are brought to a practical conclusion and to found that optical institute which has been promised for so many years.

I only ask our friend who opened the debate to consider whether the opinion of so many people who pass their lives in close touch with inventions ought not to be considered—whether it ought to be brushed aside as interested or whether he ought not to feel that there may be something in it and that perhaps the best interests of the inventors and the best interests of trade generally will not be served by those who "see red," but by those who think how best to introduce an industry to England without unduly penalizing inventors.

THE CHAIRMAN: Mr. J. Hunter Gray will perhaps speak.

MR. J. HUNTER GRAY: *Mr. Chairman, Lord Moulton, and Gentlemen*—The description Mr. Walter Reid gave us of his visit to the President of the Board of Trade reminded me of the gentleman who had a slight headache from time to time and who went to a specialist and asked him what was the best and absolutely safe cure. The specialist said, "If you get your head taken off you may be quite sure you will never have a headache again." I suggest that the section which is now under discussion was drafted on those principles.

For my sins I have had a very close association with the litigious aspect of this section from the time it became law, and I think I may say that without exception the applicant for revocation under this section was, so far as I remember, in every case a foreigner, and in no case had the applicant any intention whatever of manufacturing in this country. It is the greatest satisfaction to me to hear tonight that the master of the last two generations in the theory and practice of patent law agrees with the opinion, so far as I can gather, of the whole of this meeting, that this section can be detrimental only to invention in this country.

I want to tell you one experience, and I assure you it is not the only one (there are some here who can corroborate what I say) that I had not very long ago where an application was made under the following circumstances: A well-known motor firm was asked to give an advertisement to a particular paper, the circulation of which was stated to be 10,000, but which circulation, on inquiry, was found to be a free circulation. Naturally enough, the motor firm did not think it desirable to give an advertisement at the price asked; whereupon this particular paper informed the firm that they would apply to revoke the patents, and the result was that there were some ten or twelve—I forget the number, someone here will correct me—applications, costing 1s. each, applying to revoke the corresponding number of patents. These applications were filed in due course. Under the then practice of the Patent Office it would have been the duty of this particular firm, who are carrying on a very large business in this country, and a very profitable business both for the public and for themselves, to disclose all their books, to say what their sales were and to say to whom they sold; but, fortunately, some of us were determined that we would find out what the particular applicants knew. It cost them, I think, 14s. to make the applications. I may tell you that the capital of the Company that made the applications was 2s. paid up. Upon that it was thought proper by those who advised the patentees to object to putting in any evidence disclosing their sales, where they made them, or where they got their patented articles. The result was that these applicants, on being asked to appear before the Comptroller of Patents, decided that rather than be cross-examined they would drop the applications. But, in the meantime there had appeared all over the country advertisements about the size of one wall of this room: "10,000 motorists involved; 20 patents to be revoked." And that was the sort of thing that was exhibited all over the country.

This Section of this Act of Parliament stands today as it did then; fortunately for the public, fortunately for inventors, the High Court and the Patent Office have thought fit to make it necessary that any person who applies to revoke a patent should put forward a *prima facie* case. But, nevertheless, difficulty remains as regards the High Court because there the procedure is entirely different from that of the Patent Office. I say that the Section is an un-English Section in an English Act of Parliament; because it introduces, for the first time, the principle that a person is guilty until he proves his innocence. In any other proceeding of any kind a person is presumed to be innocent until he is found guilty; but a patentee is a criminal; he is a person who is to be loathed; he is to be attacked and he is put on his trial; he has to prove that he is an innocent man before there has ever been any evidence that he is guilty. I submit to the industry—there are many members of the industry here—that this section only requires to remain long enough to not only seriously affect invention in this country, but to ruin it. There can be no question that, although there may be thousands of perfectly useless inventions which are made by private inventors, there is the one in a thousand which is enormously valuable. One knows that the difficulties of inventors apart from this section are enormous at present, but when you have the added difficulties of compulsory working, an inventor having once been put to the trouble of having to spend £5, £10, £15, £20 or £100 on an application to revoke his patent by a foreign firm who knows nothing whatever about him, will never invent again.

In my view the position is amply covered by the 24th Section of the Act which says that anyone who wants to work a patent is entitled to apply for a compulsory license. I agree that in the past that provision in the previous Acts was a difficult one. It was provided under the jurisdiction of the Privy Council. One knew that was an expensive and a difficult proceeding. Now it is in the hands of the High Court and there is no difficulty. Every single thing that any honest person wants in order to work a patent can be got by a very simple, comparatively inexpensive method by applying for a license. It seems to me that it is perfectly ridiculous to have a section for compulsory working in view of the fact that you can apply for a compulsory license under Section 24.

THE CHAIRMAN: I am certain that you will all agree that this discussion will not be complete without our hearing the views of our Honorary Secretary, Mr. Evans-Jackson, on the subject.

MR. J. E. EVANS-JACKSON: *Mr. President, my Lord, Gentlemen, and Fellow Members*—I am quite certain you will all agree with me that the President has made a great mistake and that he ought to have closed the proceedings without calling upon the Honorary Secretary to say anything. At the same time, in the few minutes remaining, I would just like to make one or two remarks on a subject with which I am closely connected. Last year, at the Congress of the Associated Chambers of Commerce in Antwerp, I was able to carry, by a large majority, a vote of the delegates postponing the discussion on compulsory working until this year. At the last meeting of the Associated Chambers held in March last, and I have here to confirm me in what I say, Mr. Dunwoody, who is the Secretary of the Associated Chambers and Mr. Wright, who is the Secretary of the Birmingham Chamber, *viz.*, that the delegates of the various Chambers went to that Congress pledged as to the way in which their votes were to be recorded. That, to my mind, is rather an extraordinary sort of business. You have what is called the Associated Chambers of Commerce, meeting in the greatest city in the world, listening to the arguments of the greatest experts on various subjects that this and other cities can find. The delegates have put before them every argument for and against, I do not care which side it is; but when the discussion is finished the delegates have to hold up their hands in accordance with a decision which has been given probably a month before in their respective Chambers. Mr. Dunwoody, who is the Secretary of the Associated Chambers of Commerce, is here and he will confirm that what I say is correct. Now I ask whether a decision given in a meeting like that is to carry any weight with the authorities. The decision is given before the arguments are placed before the delegates.

Now, Gentlemen, on this question of compulsory working

I suppose it will probably be admitted that I have possibly some small professional experience (over thirty years); but I am putting myself tonight in the position of a business man and a man representing, to some extent, the commerce of England; and I am going to ask you this question, and it is a serious one: Whether Great Britain will benefit by the fact that John Smith, an inventor of a horseshoe, the most meritorious and extremely beneficial horseshoe, and who applies for a patent in London, also applies for patents in forty foreign countries, Germany, France, Belgium, Austria, etc. Is it to the advantage of British commerce that that inventor should be compelled to erect forty factories, one in each of forty foreign countries, to make those horseshoes, or is it more to the advantage of this country that he should manufacture the whole lot here at a cheaper rate and send them abroad?

Now, what is my point there? Of course, you do not know. I am going to put it to you. We are going to compel John Schmidt, a German, who has invented a horseshoe in Berlin, and who has taken out a patent in forty countries, including Great Britain, to build a factory here to make those horseshoes. The thing is purely illustrative of the argument as to manufacturing certain articles. We compel one foreigner to manufacture in this country the quantity required for use of this country alone, while we lay ourselves open by retaliation on the part of foreign Governments to be compelled to manufacture in forty countries the invention which has been thought out in this country.

Now, the point which appears to me to be essential is whether it is beneficial to secure the wages to the working class in manufacturing one foreign invention here and to lose the wages (which would otherwise be paid here) by being compelled to manufacture goods to meet the requirement of forty countries of a British invention abroad. Now, put it purely as a commercial and a business proposition: Ask Mr. Gordon Selfridge or Mr. Gamage or any thoughtful business men and see what they will say to you. I imagine the reply would be that the proposition was a most foolish one.

Well, I should like to say in conclusion that this question, if it is going to be carried any further with us, means retaliation. I said that at the Chamber of Commerce the other day. It has met with retaliation already. What was the effect of passing that Compuslory Working Act? The United States of America never had any compulsory working: Germany had. The moment we passed that Act in England, Germany approached the United States and completed a treaty whereby working in the United States was equivalent to working in Germany, and working in Germany was equivalent to working in the United States. Since then a similar treaty has been enacted between Germany and Switzerland, Germany and Italy, Germany and Spain, and Germany and Sweden. Now take Switzerland. Up to the time that we passed that Act here, working in any country was working in Switzerland. Now a British inventor must work his invention in Switzerland, otherwise his patent is liable to be revoked. Previous to that Act all he had to do was to work in Great Britain. Now we have under that Act no power whatever to negotiate with the United States, with Germany or with Italy and get equal conditions with those which have already been arranged and signed and sealed between the United States and Germany and other countries. I think it is neither more nor less than monstrous that Great Britain is not in a position to negotiate on reciprocal terms with other countries and say, "If you will let our people off working in your countries we will let your people off working here."

Then the last word I have to say is this, that, if any further change is made in our law at all, it should be this, that a petitioner should be compelled to go to the Comptroller and say, "I am prepared to work this patent in Great Britain, and that is the ground on which I ask that the patent shall be revoked if it is not already worked." And I should insist that in any rules or in any laws which are made in future no foreigner should come here and be allowed to revoke a patent solely for the purpose of dumping foreign goods into Great Britain.

MR. OLIVER IMRAY: Gentlemen, I just want to say this one word. I ought not to speak a second time, but it has come to my knowledge only today that the German people, in view of the Manchester Chamber of Commerce agitation for a more drastic interpretation of the present law as to the working, have approached their Government to retaliate. That is all I want to say.

MR. W. TEMPLE FRANKS, C.B., Comptroller-General of Patents: *Mr. Chairman, Lord Moulton, and Gentlemen*—It is my great pleasure and privilege to ask you to drink a toast which is not upon the list, but which none the less I think you will drink with every kind of enthusiasm and honor, and that is the toast of our Chairman tonight, Sir George Wyatt Truscott. On behalf of the guests I should like to offer him my most grateful thanks for the delightful hospitality which this Club has afforded to us and for the opportunities given us of hearing one of the most interesting debates.

As the unhappy man who has to decide the cases which have been so much discussed tonight, and whose only pleasure in that position is to hear the eloquence of my old friend, Mr. Walter, and of Mr. Colefax, and Mr. Gray, I have not been able to take part in the debate, but none the less it has been a debate fraught with the greatest interest to me and one which may have real educational influence upon those who may have in the future to decide what amendments, if any, should be made to the present Act. Whether it will be possible at any time to bring in an amending Bill to the present Act lies, I think, with my friend, Sir George Croydon Marks and his party. At present it is almost impossible to introduce legislation of that kind.

I can assure you that the substance of what has fallen from the speakers tonight, and especially from Lord Moulton, whose genius has left its mark upon all the legislation and practice in respect of industrial property in this country, will certainly be conveyed by me to the Board of Trade. The only thing I feel it possible to say in this connection is this, that I hope if any amendment is made that it will not throw further and more arduous duties upon me. The problems I have to decide at present are quite complicated enough for me and for my poor intellect; and when I confide to you that the Copyright Act has been entrusted to my care, you will understand that my time is sufficiently taken up with difficult legal problems.

If I intervene at all in the discussion, it is only to say that there may be, perhaps, between the contending parties a happy line of peace, and that is this: I understand the supporters of the present Section lament the fact that the applications for revocation of patents have enormously fallen off, and maintain in consequence that the Section is a dead letter. In that case the opponents of the Section ought really to be satisfied. On the other hand, I think it is quite possible that the mere presence of the Section, even in its present form, does assist to bring about a result which many most earnestly desire, and that is a greater willingness on the part of patentees to grant licenses with regard to patents. I only throw that out as a possibility. In any case, the debate, if I may venture to say so, has been to me of the most interesting and delightful kind, and I can only convey again my thanks to the President for allowing me the privilege of being here. I am sure I am speaking on behalf of all the other visitors here, and I ask you to drink with the greatest enthusiasm and cordiality the health of our Chairman.

THE CHAIRMAN: *My Lord and Gentlemen*—When Mr. Temple Franks first rose and addressed us I came to the conclusion that he was introducing entirely foreign matter and that I should have to call him to order; but he went on to redeem the situation and to make a very pretty contribution to our discussion here tonight. I should like to thank him on behalf of the Club for the compliment of appreciation which he has paid to us and which I very gratefully acknowledge.

ORIGINAL PAPERS

PURIFICATION OF SEWAGE BY AERATION IN THE PRESENCE OF ACTIVATED SLUDGE

By Edward Bartow and F. W. Mohlman

Received March 12, 1915

In a paper[1] read before the Illinois Section of the American Water Works Association, November 11, 1914, it was stated that experiments in the purification of sewage by aeration in the presence of activated sludge were to be carried on in the laboratory of the Illinois State Water Survey at the University of Illinois. With the advice of Professor G. J. Fowler of the University of Manchester, the experiments are following the lines described by Ardern and Lockett.[2] While we have tried to avoid a repetition of the work of Ardern and Lockett, we have found it necessary to repeat some of the experiments described by them in order to familiarize ourselves with the process, to obtain the necessary activated sludge and to study the reactions involved.

We are studying the necessary mechanical devices, the physical, chemical and biological conditions of the process and the properties of the sludge.

Since Ardern and Lockett have abandoned, for the present, experiments with continuous flow devices, we also are confining our experiments to an intermittent system. Our first experiments were made using bottles of three gallons capacity. Later, we constructed a tank 9 inches square and 5 feet deep. This tank has plate glass front and back to permit easy observance of the condition of the sewage and sludge. A porous plate was placed 4 inches above

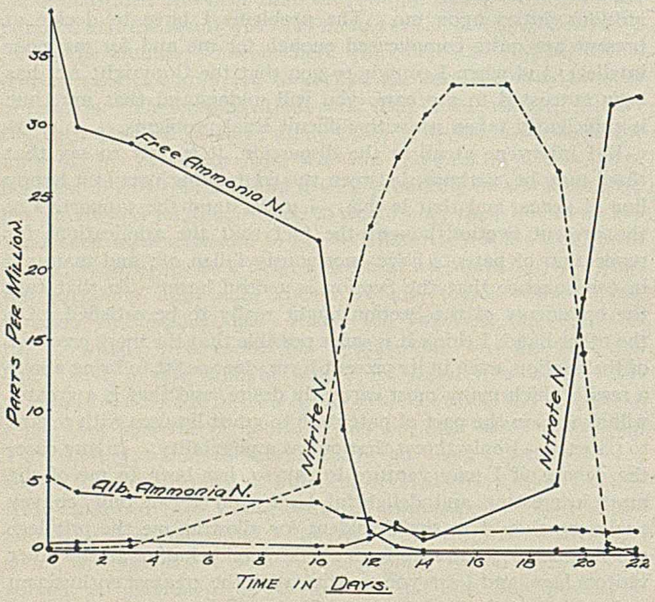


Fig. I—Nitrification of Sewage. No Activated Sludge Present

the bottom. An inlet for air and an outlet for any water which might pass through the plate were provided in the space below the plate. Compressed air furnished by the University power plant is used. All air is measured through an ordinary gas meter. The purified sewage is removed by means of a siphon. Experiments have been carried out in the laboratory at room temperature, thus far, with no special precautions to regulate the temperature.

For our experiments, sewage from the city of Champaign is used. It is collected from a point in the main

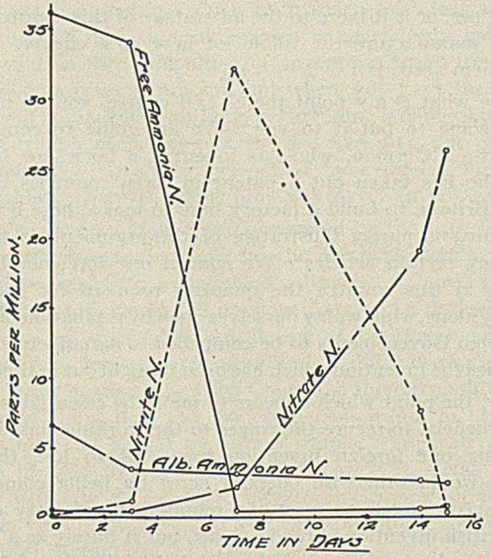


Fig. II—Nitrification of Sewage. No Activated Sludge Present Uniform Distribution of Air through Porous Plate

sewer at the edge of the city, at least two miles from the outfall. When taken it is fresh. Average analyses indicate that it is a fairly strong, domestic sewage. It contains no trade wastes.

AERATION OF RAW SEWAGE WITHOUT THE ADDITION OF SLUDGE

Air has been blown into five separate portions of sewage until complete nitrification was accomplished. To show the progress of the reaction, tests for free ammonia, nitrites and nitrates were made at intervals during each treatment. The time required for complete nitrification has varied from 15 to 33 days. The best result was obtained in the tank, where the air was distributed through the porous plate. For all analyses, samples of the supernatant liquid were taken after one hour settling without filtration. In each case, the *free ammonia* nitrogen was almost quantitatively changed to *nitrite* nitrogen, then the *nitrite* nitrogen in turn was changed almost quantitatively to *nitrate* nitrogen. This change is illustrated in Table I, A and B and Figs. I and II.

The formation of nitrate in the tank was accomplished in 15 days with the use of 4830 cu. ft. of air.

AERATION OF RAW SEWAGE WITH SLUDGE

The supernatant liquid was siphoned off and a fresh portion of sewage added to the sludge. In this, the second treatment, the effect of a small amount of sludge is very nicely illustrated by the reduction of the time required for complete nitrification from 15 to 4 days, and the reduction in the amount of air used from 4830

[1] "Observations of Some European Water Purification Plants and Sewage Disposal Works," *Jour. A. W. W. A.*, March, 1915.

[2] *J. Soc. Chem. Ind.*, **33**, 523–39, 1122–4.

to 1270 cu. ft.: 34 parts per million of free ammonia nitrogen in the raw sewage produced 23.8 parts per million of nitrate nitrogen in the supernatant liquid.

TABLE I—NITRIFICATION OF SEWAGE: WITH AND WITHOUT SLUDGE

Date	Time Days	Free NH_3	Alb. NH_3	Parts per Million Nitrogen as Nitrites	Nitrates
A—No Activated Sludge Present					
Dec. 18, 1914	0	38.00	5.20	0.07	0.37
19	1	30.00	4.20	0.02	0.38
21	3	28.80	4.00	0.11	0.45
28	10	22.00	3.60	5.00	0.20
29	11	8.80	2.60	16.00	0.40
30	12	1.60	2.40	23.00	1.00
31	13	0.36	1.88	28.00	2.00
Jan. 1, 1915	14	0.16	1.48	31.00	1.00
2	15	—	—	33.00	—
4	17	—	—	33.00	—
5	18	—	—	30.00	—
6	19	0.28	1.92	27.00	5.00
7	20	0.44	1.84	14.00	18.00
8	21	0.28	1.68	.30	31.70
9	22	0.24	1.60	.05	31.95
B—No Activated Sludge Present: Uniform Distribution of Air through Porous Plate					
Jan. 4	0	36.00	6.60	0.01	0.71
7	3	34.00	3.40	1.20	0.60
11	7	0.40	3.00	32.00	2.00
18	14	0.60	2.60	7.50	18.50
19	15	0.80	2.20	0.10	25.90
C—Activated Sludge Present (1 Sludge: 5 Sewage): Uniform Air Distribution					
	Hours	Free NH_3			
Feb. 24, 1915	0	27.00		0.05	0.59
	1	13.00		2.40	6.00
	2	8.20		2.80	10.80
	3	3.70		3.40	15.00
	4	0.20		2.60	18.60
	5	0.20		0.30	22.10

The supernatant liquid was again siphoned off, fresh sewage added and aeration continued. In this, the third treatment, nitrification was complete in two days and but 720 cu. ft. of air were used: 33 parts per million of free ammonia nitrogen produced 22.3 of nitrate nitrogen. In the twelfth treatment the purification was completed in less than 8 hours with the use of less than 128 cu. ft. of air and 36 parts per million as free ammonia nitrogen produced 29.5 parts per million of nitrate nitrogen. In the thirty-first treatment with sludge and sewage in the proportion of 1:5, purification was complete in less than 5 hours: 35 cu. ft. of air were used, equal to 0.20 cu. ft. per sq. ft. of surface area per minute, or about 3 cu. ft. per gallon of sewage. We have not yet attempted to determine the minimum amount of air required.

Samples taken at the end of each hour of aeration during some of the treatments have been tested for stability. A sample taken at the end of one hour aeration in the thirty-first treatment had not decolorized methylene blue at the end of twelve days. Since in one hour nitrification was not complete, it is, therefore, evidently unnecessary to obtain complete nitrification in order to obtain a stable effluent. Since it is impossible to separate the oxidized liquid entirely from the sludge it is probable that the stability is promoted by the oxidizing action of the nitrate in the residual liquid.

The progress of nitrification in the presence of activated sludge is apparent. The results are shown in Table IIIC and Fig. III. From this and from other series of analyses it is indicated that there is no quantitative conversion of free ammonia to nitrite, followed by oxidation to nitrate, but that nitrates are formed simultaneously with nitrites.

The number of bacteria were determined during one treatment. Samples were taken after one hour settling. The raw sewage showed a bacteriological content of 750,000 per cc. The supernatant liquid after aeration and settling one hour showed but 20,000. Further tests are planned. These we expect will include the determination of species.

Through the courtesy of Professor Frank Smith, Professor of Systematic Zoölogy of the University of Illinois, biological examinations have been made of the sludge. Among the microscopic animals found are many Vorticella and Rotifera, but the predominant organism is an annelid worm, known as *Aeolosoma hemprichi*. This organism is about 2 to 5 mm. long and quite slender. It abounds in various kinds of freshwater bodies where there is an abundance of decaying organic material, and thrives especially well where there is much fermentation and in waters contaminated with sewage, provided there is an abundance of oxygen. It belongs to a group of worms in which reproduction occurs very rapidly by asexual methods. A fission zone is formed near the middle of the body of the parent worm and develops the head of one daughter worm and the tail of the other, and thus two

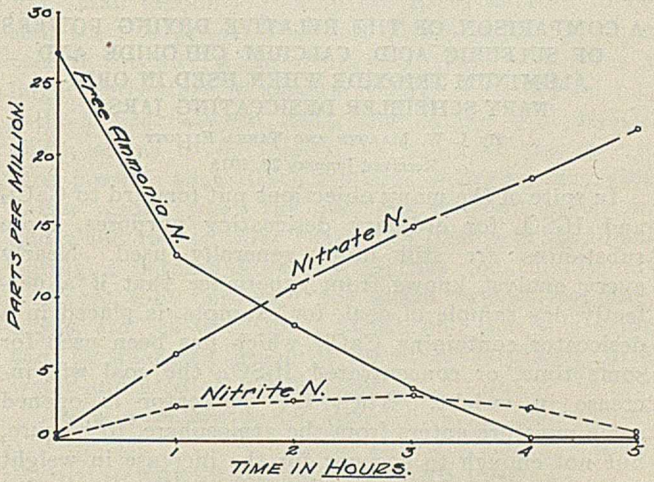


FIG. III—NITRIFICATION OF SEWAGE. ACTIVATED SLUDGE PRESENT. 1 SLUDGE: 5 SEWAGE.

new worms are formed from one. This requires not over two or three days and is repeated for an indefinite number of generations. It feeds greedily and almost continuously on any small organic particles that it can obtain and presumably destroys at least its own weight of organic matter every day and probably more. Because of the mode of reproduction, it takes but a short time to produce extensive colonies with great capacity for the destruction of organic material.

SLUDGE—The activated sludge has evidently been developed by the multiplication of these worms originally present in the sewage, and the species found at varying points might differ. The sludge does not have an unpleasant odor, due to the fact that it consists largely of living organisms. If kept for a long time in a moist condition without air, it will putrefy.

COMPOSITION OF SLUDGE—Analyses of the sludge made by Hatfield have shown the following results: After drying first on the water bath and then for three hours in an oven at 100° the loss, or moisture, was 95.54 per cent. The dried material contained 6.3

per cent nitrogen, 4.0 per cent fat, 1.44 per cent phosphorus (equivalent to 3.31 per cent P_2O_5) and 75 per cent volatile matter by loss on ignition.

From this chemical data the dried sludge would evidently have value as a fertilizer. If we calculate the value as 20 cents per lb. of nitrogen and 12 cents per lb. of phosphorus, it would have a market value of $29.00 per ton. In order to determine whether the theoretical value would correspond to the actual value, pot cultures have been started. Portions of dried sludge were added to two pots, an equivalent amount of nitrogen from dried blood to a third, and nothing to a fourth. At the end of 18 days the cultures containing the dried sludge show better growths than the culture containing an equivalent amount of nitrogen from dried blood and far better growth than the culture to which no additional nitrogen was added.

A plant to operate on a larger scale is under construction and the authors propose to continue the experiments.

State Water Survey, University of Illinois
Urbana

A COMPARISON OF THE RELATIVE DRYING POWERS OF SULFURIC ACID, CALCIUM CHLORIDE AND ALUMINUM TRIOXIDE WHEN USED IN ORDINARY SCHEIBLER DESICCATING JARS[1]

By J. W. Marden and Vanna Elliott

Received January 28, 1915

In spite of the many objections put forward to $CaCl_2$ and H_2SO_4 for ordinary desiccating purposes, these substances are still quite generally used. Nearly every analyst knows from experience that if a perfectly dry sample of coal, for example, is placed in a desiccator containing $CaCl_2$, which has been used for some time, or concentrated H_2SO_4, the coal will increase in weight. When the desiccator is opened some moisture enters from the atmosphere, to be sure, but not enough to account for the increase in weight of the coal.

As compared to the wide use to which H_2SO_4 and $CaCl_2$ are put as drying agents for organic substances which cannot be heated, the literature on the subject is meager. The desiccating efficiency of several substances like $CaCl_2$, Na, fused NaOH, P_2O_5, etc., has been tried. Baxter and Warren[2] tried $CaBr_2$, $ZnBr_2$ and $ZnCl_2$ by passing moist air over them. They found that H_2SO_4 was more efficient than any of these. Johnson[3] has published a note on the use of Al_2O_3 as a desiccating agent in which it is claimed that Al_2O_3 is more effective than H_2SO_4 for removing moisture from air saturated with water vapor.

In the hope of suggesting a good substitute for the time-worn $CaCl_2$, if not for H_2SO_4, in ordinary desiccation, the present work was undertaken. Also, a series of experiments with H_2SO_4 has been run to show the effect of the concentration of the acid on drying certain substances, and it is hoped that the results will throw some light on the vagaries of H_2SO_4 as a desiccant. Many analysts seem in doubt regarding the total amount of moisture that is obtained by H_2SO_4 drying; some have the opinion that they get all but two- or three-hundredths of one per cent in most cases, while others think that they obtain very much less than that percentage of moisture. At best, any drying method with H_2SO_4 can be only an arbitrary one. Since this is an old subject, most of the experimental work for this paper is given in abstract.

Many experiments have shown that from certain substances all of the moisture cannot be obtained by the ordinary H_2SO_4 drying method at 25° C. A sample of pure sugar syrup, for example, containing 49.89 per cent moisture, mixed with ten times its weight of sand, yields an average of about 48.17 per cent moisture. With maple syrup, even with vacuum, the same condition is observed. The percentage of moisture obtained by H_2SO_4 drying is less than that obtained by the refractive index or by heating at 100° C. This behavior of sugar, although somewhat exaggerated, is typical of the behavior of other substances. The water-vapor pressure of some materials still containing residual moisture is as low as that of the H_2SO_4 over which they have been dried. It has been shown that considerable amounts of H_2SO_4 distil off in vacuum, and for this reason Gore[1] suggests the use of CaO for high vacuums. By graphic interpolation, concentrated (95%) H_2SO_4 has a vapor pressure of about 0.03 mm. at 25° C.

According to Thorpe[2] the speed of drying is hastened but no more moisture is obtained by the use of vacuum. In a series of trials with cheese, syrup, coffee, etc., using both H_2SO_4 and $CaCl_2$, slightly more moisture was obtained with vacuum than without.

In one instance it was as much as 0.7 per cent and in other cases quite small.

The effect of a fairly large variation in the concentration of H_2SO_4 changes the total amount of moisture removed from some substances very slightly; in other cases, however, the change is marked. Table I shows the results obtained with flour, cane-sugar syrup and cheese dried to constant weight over various concentrations of H_2SO_4. Each sample for each concentration was dried in an individual desiccator.

Table I—Effect of Concentration on Drying Power of H_2SO_4
Atmospheric pressure and laboratory temperature
Total time of drying: about three weeks

Per cent H_2SO_4	Vapor pressure mm. of Hg (approximate)	Per Cent Water in White flour	Per Cent Water in Cane syrup	Per Cent Water in Cheese
95	(0.03)?	12.48	48.28	26.51
84.8	0.18	12.28	48.25	26.10
78.3	0.8	10.04	48.27	25.58
65.6	2.7	7.22	48.10	24.88
62.6	3.5	2.89	47.97	23.47
37.0	15.0	0.10	47.30	21.18
29.6	17.5	...	34.70	...
21.9	20.0	...	22.01	...
15.2	21.0	...	0.29	...
7.0	22.5	...	49.4 (increase in weight)	
Per cent moisture found by drying at 100° C. to constant weight		11.85	49.78	26.65
Polariscope		...	49.89	...
100 per cent(a) H_2SO_4		12.55	48.28	26.65

(a) Values obtained by plotting percentage moisture against percentage H_2SO_4.

It will be seen from Table I that cane syrup could be dried about as well, although, as laboratory ex-

1 This work was started in the laboratory of the South Dakota State Food and Drug Department.

2 *J. Am. Chem. Soc.*, **33** (1911), 340.

3 *Ibid.*, **34** (1912), 912.

1 *J. Biol. Chem.*, **15**, 259–61.

2 "Dictionary of Applied Chemistry," Vol. II, p. 210 (1912). Longmans, Green & Co.

perience showed, not as quickly, over 75 per cent as over 100 per cent H_2SO_4. With cheese the percentage of moisture obtained over 100 per cent H_2SO_4 is about the same as that by drying to constant weight at 100° C. Flour shows another example of the increase in weight of some materials on heating, due to a certain amount of oxidation. Skertchly[1] has pointed out inconsistencies of this kind which he found while drying biscuits.

As has been suggested by several authors, exposing a substance over varying concentrations of H_2SO_4 and finding the concentration at which it neither gains nor loses weight indicates the concentration of H_2SO_4 which has the same vapor pressure as the material. In this way flour had a vapor pressure of about 15.0 mm. and cane-sugar syrup of about 21.0 mm.

Hempel[2] has shown that the rate at which substances dry depends upon the rate at which water vapor is transferred. Since air saturated with water vapor is less dense than unsaturated air, Hempel puts the H_2SO_4 in the upper part of the desiccating jar. Similarly, if air currents can be formed in the jar, the drying will go much faster. To show this point, samples of maple syrup were dried over 95 per cent H_2SO_4 at room temperature in two desiccators; in one a small motor was introduced and the air stirred vigorously during the experiment. In one and one-half hours as much moisture was removed with stirring as was removed without stirring in six hours.

Several portions of Al_2O_3 were prepared for comparison with the other desiccants. The Al_2O_3 used in the preliminary trials was prepared from "technical" $Al_2(SO_4)_3$ by dissolving the salt in water and precipitating the $Al(OH)_3$ with NH_4OH. The aluminum hydroxide was filtered off and dehydrated in the glass tube of a combustion furnace with the smoky flame. The Al_2O_3 employed in the later experiments was made in the same way, except that "C. P." $Al_2(SO_4)_3$ was used in the preparation and the $Al(OH)_3$ was washed many times to remove any impurity which might lead to erroneous results.

Preliminary experiments comparing Al_2O_3 with $CaCl_2$ showed that in nine days at laboratory temperature and pressure, a sample of coffee yielded 0.2 per cent more moisture over Al_2O_3 than over $CaCl_2$. In the same length of time a sample of sugar yielded the same weight of moisture over either. The percentage of moisture in this case, however, was very low. Trials were made, also, by placing weighed dishes of Al_2O_3 over H_2SO_4 and H_2SO_4 over Al_2O_3 to see which would increase in weight more rapidly. The moisture introduced by opening the desiccator was enough to vitiate the results somewhat, but the Al_2O_3 increased in weight faster than the H_2SO_4. The following table shows the percentage of moisture obtained with three common materials dried over the three desiccants and kept in a thermostat at 25° C. Each percentage shown is the average result of duplicate experiments in individual desiccators over the same weight of desiccant.

[1] *J. Soc. Chem. Ind.*, Jan., 1913.
[2] *Ber.*, **23** (1890), 3566.

TABLE II—PERCENTAGES OF MOISTURE BY DIFFERENT DESICCANTS

SUBSTANCE	FLOUR			$CuSO_4.5H_2O$			COFFEE	
Time Days	Al_2O_3	H_2SO_4 95 per cent	$CaCl_2$	Al_2O_3	H_2SO_4 95 per cent	$CaCl_2$	Al_2O_3	$CaCl_2$
1	8.42	8.42	8.47	14.12	15.08	15.22	1.31	1.17
2	9.51	9.56	9.21	18.76	19.47	16.84	1.98	1.82
3	10.30	10.33	10.06	23.73	25.51	21.31	2.66	2.38
4	10.67	10.61	10.35	28.11	28.74	25.40	3.11	2.92
5	11.08	10.96	10.62	29.36	29.46	28.77	3.30	3.11
6	11.21	11.13	10.75	29.43	29.45	29.32	3.44	3.22
7	11.46	11.33	10.96	29.53	29.54	29.42	3.54	3.32
8	...	...	...	...	...	...	3.66	3.46
10	...	...	...	29.53	29.54	29.42	..	..
11	11.75	11.64	11.15	...	...	...	..	3.46
13	11.75	11.64	11.15	29.53	29.54	29.42	..	..

The time values in Table II are given roughly in days, which intervals are close enough to show the points in question. Some of the moisture in the blue vitriol was lost in grinding the sample.

The work in Table II was repeated in vacuum desiccators at a pressure of about one-tenth atmosphere and at laboratory temperatures. As before, three substances, flour, blue vitriol and tea, were dried over the three desiccants. Although there was some difficulty in obtaining desiccating jars with the same power for "holding" the vacuum, the average results were in the same order as in the above table. For small amounts of moisture Al_2O_3 appears to be somewhat superior to either H_2SO_4 or $CaCl_2$, when used in this way, while with $CuSO_4.5H_2O$, which has a larger percentage of moisture, there seems to be but little choice between Al_2O_3 and 95 per cent H_2SO_4. $CaCl_2$ seems to be inferior to either of the others. It is possible that H_2SO_4 methods of drying may give better results when the acid has frequent agitation, and when two or three charges of fresh acid are added during a determination. Al_2O_3 has the further advantages that one need not guard against slopping, burns, etc., as when using H_2SO_4 and that this oxide can be reheated when it becomes saturated with water and used again and again.

UNIVERSITY OF MISSOURI, COLUMBIA

THE OLEORESIN OF SAND PINE

By A. W. SCHORGER

Received December 28, 1914

The sand pine (*Pinus clausa*, Sarg.) is practically confined in its range to the State of Florida. It is a small tree whose branches extend to the ground, the height being usually 15 to 20 feet, while a diameter of 1 foot is rarely exceeded. The material examined was obtained on the Florida National Forest from near Ocala, Florida.

OLEORESIN—The oleoresin contained considerable water and small trash of such a nature that an unusually low-grade rosin for virgin "gum" was obtained. Analysis gave the following results:

	Per cent
Volatile oil	18.93
Rosin (Grade G)	72.30
Trash	2.67
Water	6.10

VOLATILE OILS—The volatile oils obtained from two samples of oleoresin were practically identical. Their properties were as follows:

	$d\frac{15°}{15}$	$n_{D}15°$	$a_{D}20°$
(1)	0.8725	1.4768	—22.49
(2)	0.8723	1.4767	—22.80

On fractional distillation with a 12-inch Hempel column, 60 per cent of the oil distilled between 161° and 165°, and 35 per cent between 165° and 167°. The above data show that the volatile oil is entirely different from ordinary gum turpentine.

IDENTIFICATION OF CONSTITUENTS

α-PINENE—Repeated fractionation yielded 48 g. (9.6 per cent) boiling between 157° and 160° and having the constants $d_{15°}$ 0.8656, $a_{D20°}$ —30.17°. The oil gave a low yield of pinene nitrosochloride, which was transformed to the nitrolpiperidine compound melting at 119°.

CAMPHENE—Between 160° and 162°, 50.5 g. (10.1 per cent) of oil were obtained having the following properties: $d_{15°}$ 0.8671, $a_{D29°}$ —29.31°. The oil was treated with a mixture of glacial acetic acid and sulfuric acid in the usual way. The oil recovered by steam distillation after saponification would not crystallize on cooling in a freezing mixture. On distilling the oil and rejecting the portions boiling below 190°, the residue readily crystallized on cooling. After removing the crystals with the aid of a force filter and recrystallizing four times from petroleum ether the isoborneol melted at 207–209°, resolidifying on slow cooling at 208°. A fifth crystallization did not raise the melting point.

β-PINENE—The β-pinene fractions constituted about 75 per cent of the oil, so that this terpene is the major constituent. A portion of the β-pinene was oxidized with alkaline potassium permanganate. Ten grams of the sodium nopinate obtained yielded on further oxidation 2 grams of nopinone whose semicarbazone melted at 189°.

Since the oil consisted so largely of β-pinene it was thought possible to isolate this terpene in a fairly pure state. After 10 fractionations over metallic sodium, two fractions were obtained that showed fairly constant boiling points. Below will be found the properties of the two fractions and of one of the synthetic β-pinenes prepared by Wallach:

	B. p.	$n_{D20°}$	$d\frac{20°}{20°}$	$[\alpha]_D$	M found	Calculated for $C_{10}H_{16}$ $\vert$=
(1)......	164–165°	1.4772	0.8700	—26.00°	44.19	43.54
(2)......	165–166°	1.4784	0.8709	—23.73°	44.23	43.54

Wallach's[1] synthetic β-pinene:

B. p.	$n_{D22°}$	$d_{22°}$	a_D	M found	Calculated for $C_{10}H_{16}$ $\vert$=
163–164°	1.4724	0.8660	—22° 20′	44.13	43.54

Fraction 2 was about four times as large in quantity as Fraction 1. The values obtained for all the constants are higher than those recorded by Wallach, and this had been the author's general experience in the examination of various essential oils in which β-pinene was the chief constituent. To determine whether this condition was due to the presence of camphene, 50 g. of Fraction 2 were treated with the mixture of glacial acetic acid and sulfuric acid. No isoborneol, however, could be detected.

ROSIN—The rosin, grade G, had an acid No. of 172.5 and a saponification number of 178.7. It yielded 4.01 per cent of resene soluble in petroleum ether.

The rosin crystallized very readily from acetone or alcohol. After ten crystallizations from acetone, the crystals obtained began to soften at 147°, melted at 150–151°, and were completely liquid at 157°. Another portion of the rosin was first crystallized twice from alcohol containing 10 per cent concentrated hydrochloric acid and then recrystallized repeatedly from 95 per cent alcohol. When allowed to crystallize slowly the abietic acid was obtained as large triangular crystals. The crystals finally obtained began to melt at 157–158° and were completely liquid at 167°. Using an alcoholic solution the abietic acid had the specific rotation $[\alpha]_D$ —85.46° calculated from the following values:

a.............	6.74°	p 9.433
l.............	1	d 0.8357

The silver salt was obtained by neutralizing an alcoholic solution of the acid with sodium hydroxide and adding the calculated quantity of $AgNO_3$ in a large volume of alcohol. The silver salt was filtered off, washed repeatedly with alcohol, then with ether and dried at 70°. Analysis of the silver salt follows:

0.4685 g. silver salt gave 0.1234 g. Ag = 26.34 per cent Ag
Calculated for silver abietate, $Ag(C_{20}H_{29}O_2)$, 26.37 per cent Ag

CONCLUSIONS

The volatile oil of the sand pine (*Pinus clausa*, Sarg.) has approximately the following composition: *l*-α-pinene, 10 per cent; *l*-camphene 10 per cent; *l*-β-pinene 75 per cent; losses by polymerization, etc., 5 per cent.

The "rosin" contains 4.0 per cent resene while the remainder consists mainly of abietic acid.

FOREST PRODUCTS LABORATORY
MADISON, WISCONSIN

[1] *Ann.*, **363** (1908), 1.

THE CONDITIONS OF NATURAL GAS IN THE EARTH'S STRATA[1]

By GEORGE A. BURRELL

Received November 28, 1914

In this paper are recorded some observations and experiments regarding the liquid or gaseous occurrence of natural gas in the earth's strata. This question has been a subject for conjecture in the past, but to date, in the case of most natural gases, no exact data have been available from which to draw definite conclusions, because the exact composition of natural gases has not been known. Knowing (1) the composition of a natural gas, (2) rock pressures that prevail in natural-gas strata, (3) temperatures that prevail in natural-gas strata, and (4) the temperature and pressures that are necessary for the liquefaction of the gaseous paraffin hydrocarbons, one can obtain evidence regarding the liquid or gaseous occurrence of natural gas in the earth. The vapor pressures of some of the paraffin hydrocarbons are shown in the following tables. The data were taken from Landolt and Börnstein's "Physikalische Chemische Tabellen."

The results of a complete analysis including the quantity of each paraffin hydrocarbon as found by liquefaction and fractionation follows. For compari-

[1] Paper presented at the Spring Meeting of the American Chemical Society, Cincinnati, Ohio, April 6–10, 1914, by permission of the Director of the Bureau of Mines.

Table I—Vapor Pressures of Seven Paraffin Hydrocarbons

Name	Formula	Boiling point ° C.	Critical temperature ° C.	Critical pressure Lbs.	Critical pressure Atmos.
Methane	CH_4	—160	—99.5	735	50
Ethane	C_2H_6	— 93	35	662	45
Propane	C_3H_8	— 45	97	647	44
N-Butane	C_4H_{10}	1	...	...	..
N-Pentane	C_5H_{12}	36.4	...	...	..
N-Hexane	C_6H_{14}	68.4	...	...	..
N-Heptane	C_7H_{16}	98.4	...	...	..

Table II—Vapor Pressures of Methane, Ethane and Propane

Methane(a) Atm.	Methane(a) Pr. at ° C.	Ethane(a) Atm.	Ethane(a) Pr. at ° C.	Propane(a) Atm.	Propane(a) Pr. at ° C.
50	— 95.5(a)	45.3	35(a)	44	97(a)
26.3	—105.8	32.3	15	9	22
21.4	—110.6	23.3	0	7.1	12.5
11	—126.8	18.3	—11	4.8	— 2
6.2	—138.5	14.5	—21	2.7	—19
2.24	—153.8	11	—31	1.8	—33
1	—165(b)	1	—93(b)	1	—45(b)

(a) Critical constants. (b) Boiling point.

son, the results of a eudiometric analysis of the natural gas are also included:

Table III—Analytical Results Obtained by Two Methods

Percentages	Liquefaction and fractionation	Eudiometric analysis
Methane	84.7	79.2
Ethane	9.4	19.6
Propane	3.0	..
Butane (chiefly)	1.3	..
Nitrogen	1.6	1.2
Totals	100.00	100.00

Included in the above analysis is 0.03 per cent carbon dioxide. It is scarcely necessary to state that the eudiometric determination shows only approximately the quantity of hydrocarbons in a natural-gas mixture.

From the fractionation analysis and other data one can calculate the pressures that would be required to liquefy the different constituents at particular temperatures. To start the liquefaction of the methane there would be required a pressure of at least $\left(\frac{100}{84.7}\right)735 =$ 868 lbs. per sq. in. at —95.5° C. That is, in order to put 735 lbs. pressure on the methane there would be required a pressure of 868 lbs. on the mixture; as liquefaction proceeded and the partial pressure of the methane decreased proportionally greater pressure would be required to continue the liquefaction.

To liquefy the ethane there would be required a pressure of at least $\left(\frac{100}{9.4}\right)662 = 7064$ lbs., at 35° C. To liquefy the propane at 97° C., there would be required a pressure of $\left(\frac{100}{3.0}\right)647 = 21,567$ lbs. These calculations were made at the critical temperatures and pressures of the paraffin hydrocarbons. The critical constants for butane have not been determined.

Earth temperatures increase about 1° C. for each 60 or 70 ft. of depth. This is a thermal gradient that has been determined by measuring temperatures in many bore holes, although increases in temperatures different from the foregoing have been determined by some investigators. If the initial temperature is 20° C., and an increase of 1° C. for each 70 ft. takes place, strata at a depth of 2000 ft. (not an uncommon depth for a gas well) should have a temperature of 48° C.

Methane may be dismissed as ever occurring in the liquid condition because even at —95.5° C. there is required a pressure of at least 735 lbs. per sq. in. to liquefy it when it occurs in the pure state. Mixed with other gases, so that its partial pressure is less than one atmosphere, there are required proportionally greater pressures at any particular temperature.

The critical temperature of ethane is 35° C., which is not far from gas-strata temperatures. However, the pressures required to liquefy the ethane in Pittsburgh natural gas at the critical temperature is 7064 lbs. and is far above gas-strata pressures. It is questionable whether pressures as high as 1500 lbs. have ever been measured in a gas well. 1000 lbs. per sq. in. is high.

The vapor pressure of liquid propane at 22° C. is 132 lbs. (9 atmospheres). Vapor pressures at temperatures closer to gas-strata temperatures than this have not been determined. To liquefy the propane in Pittsburgh natural gas at 22° C. there would be required a pressure of $\left(\frac{132}{3.0}\right)100 = 4400$ lbs. This is also a pressure much greater than is found in natural-gas strata.

Vapor pressures of butane at different temperatures other than the boiling point have not been determined. At 1° C. (boiling point) there would be required a pressure of about 1153 lbs. to liquefy the butane in Pittsburgh natural gas. At higher temperatures there would be required greater pressures. Hence, the butane in Pittsburgh natural gas can also be dismissed as occurring in the liquid condition in the earth.

In view of the above considerations, it can be stated that the essential constituents of Pittsburgh natural gas never occur in the strata in the liquid form, because rock pressures are not high enough, rock temperatures are not low enough, and the quantities of the more easily condensable constituents in the gas mixture are not great enough for this condition. The natural gas used in Pittsburgh is typical in composition of gas that is supplied to many cities to the extent of billions of cubic feet per year.

The condition of natural gas in the earth is of importance, for, if present therein as a liquid, it would be possible for a single subterranean reservoir to furnish a much larger supply of gas than if present in the gaseous condition. The foregoing vapor pressures and percentage composition of the gas are also instructive as showing the pressure that would have to be applied to liquefy the various constituents in a compressor plant.

As somewhat different from the natural gas mentioned above, which is contained in rock strata under heavy pressure, there may be mentioned those natural gases that issue from the casing heads of oil wells under slight pressure, or are withdrawn from the casing heads at pressures less than atmospheric. These gases frequently contain, besides some of the gases already mentioned, enough of the vapors of the liquid paraffin hydrocarbons to warrant the installation of a plant for the condensation of gasoline.

The question arises as to the liquid or gaseous condition of these casing-head gases in the earth. The quantities of the more easily liquefied gases are much higher than in the so-called dry gases, but, on the other hand, the pressures in the rock strata from which they issue or are drawn are almost invariably much lower, so that the chances of them occurring in the liquid condition are small. No account is taken herein of gases that are closely associated under heavy pressure with oil in the sands. Under such condition there is a solution of gases in the oil to a great extent. The natural gas used in Pittsburgh is not associated with oil in the earth's strata.

Chemical Laboratory
Bureau of Mines, Pittsburgh

THE ANALYSIS OF CHROME YELLOWS AND GREENS

By A. Given

Received January 22, 1915

From inquiries received at this laboratory, it appears that the determination of the composition of chrome yellows and chrome greens is not well understood in many color and paint works; and the excellent publications of the Bureau of Standards on the analysis of inks help only in a degree. The method here given is the result of a great deal of work and experience with these colors, and has given excellent satisfaction.

METHOD

MOISTURE AND LEAD CARBONATE—Weigh out accurately about 1 gram of the yellow or green into a small beaker, and dry for 4 hours at 105–110° C. Calculate the loss in weight as water. Add 50 cc. of 50 per cent acetic acid to the dry substance in the beaker, mix thoroughly, and let stand over night. Filter through a tared Gooch, wash with hot water, dry, cool and weigh. Calculate the loss from dry weight as lead carbonate.

LEAD SULFATE AND CHROMATE—Weigh out accurately about 1 g., wash into a 250 cc. beaker, add 50 cc. water and 50 cc. of 25 per cent caustic soda and boil for 5 or 10 minutes. Filter through a tared Gooch, wash thoroughly with hot water, cool the filtrate and make up to 250 cc. Save the residue. To 50 cc. of the solution add an excess of hydrochloric acid and 5 cc. alcohol and boil until the chromate is reduced to chromic chloride. Add an excess of barium chloride, boil, let settle, filter on an ashless paper, wash, burn and weigh as barium sulfate. Calculate to per cent lead sulfate.

To 50 cc. of the above solution add an excess of nitric acid, heat to boiling and add 25 cc. boiling saturated solution of potassium bichromate. Boil 1 minute, let settle, filter through a tared Gooch, wash, dry and weigh. Calculate as per cent lead chromate. From this amount subtract the lead sulfate and lead carbonate, both calculated to lead chromate, and call the difference actual lead chromate present.

RESIDUE—Fill the Gooch containing the residue from the solution for lead sulfate and chromate with hot 1 : 1 hydrochloric acid, let stand 10 minutes, filter and wash with hot water. Repeat twice, wash thoroughly, dry and weigh. Calculate remaining residue as per cent barytes or china clay according to base.

PURE BLUE—The sum of all the previous determinations is subtracted from 100, and the difference called pure blue.

Laboratories of Morris Herrmann and Company
878 Mt. Prospect Avenue, Newark, New Jersey

THE UTILITY OF SULFUROUS ACID AND PURE YEAST IN CIDER VINEGAR MANUFACTURE

By W. V. Cruess, J. R. Zion and A. V. Sifredi

Received January 4, 1915

A study of methods of alcoholic fermentation of apple juice destined to be made into vinegar in various California factories showed that in almost every case no attempt was made to control the microörganisms of fermentation. A brief description of the various ways of handling the cider stock will no doubt be of interest.

In one of the largest factories the cull apples and peels and cores from apple driers are ground or "grated" in an Ohio apple grater as soon as received. The juice is pressed out with heavy screw presses driven by a motor and cog gearing with a capacity of 60 tons per day. The juice goes to 20,000 gallon tanks. The first tank of the season is started with a large starter of compressed yeast. When this tank is in fermentation, about one-third of its contents is used to start the next tank. The third tank is started from the second, and so on through the whole series of tanks. Over 500,000 gallons are made in this way during a season. Examination of the fermented juice showed it to be "dry;" that is, practically free from unfermented sugar, but it was shown by microscopical examination to contain large numbers of lactic acid bacteria and the large tanks soon developed a heavy growth of *mycoderma* (wine flowers) after alcoholic fermentation. The lactic bacteria develop a "mousey" flavor and the mycoderma rapidly oxidizes alcohol to CO_2 and H_2O without forming any corresponding amount of acetic acid.[1] Laboratory tests demonstrated that mycoderma isolated from cider was capable of destroying all of the alcohol of a fermented orange juice containing 4.5 per cent alcohol in three weeks. The gravity of heavy mycoderma growth may be seen from these figures.

Another large factory stores its cull apples, peels and cores in a large wooden bin. Often this material undergoes a fermentation, resembling silage fermentation, before it can be crushed. The juice after crushing and pressing is allowed to undergo spontaneous fermentation in 30,000-gallon tanks. Wild yeasts, lactic bacteria and mycoderma develop profusely, giving a very cloudy cider. Occasionally a tank "sticks" with some unfermented sugar, but in general the fermentations are complete.

A third factory (until 1914) crushed its apples and allowed the crushed apples to undergo spontaneous fermentation 3 or 4 days before pressing. This method gave a high yield of juice, due to the softening effect of the fermentation. Beginning with this season, this factory used pure "Burgundy" wine yeast on the crushed apples with good results. The yeast was propagated according to *Bulletin* 230 of the University of California Experiment Station. No sulfurous acid is used on the crushed apples, consequently the fermented cider shows a strong tendency to develop mycoderma.

The above factories all use the generator process

[1] A. V. Sifredi, Thesis for M. S., Univ. Calif., Dec., 1914.

for converting the alcohol to acetic acid. A fourth factory making 50,000 to 75,000 gallons per year uses the slow process throughout. Fermentation is allowed to take place spontaneously with the result that lactic acid bacteria, as well as mycoderma, grow vigorously in the fermented cider. There are also a few fermentations that "stick," *i. e.*, stop before the sugar is completely transformed to alcohol.

On account of these obvious defects in present methods, the experiments described below were carried out to see if the beneficial effects of pure yeast and sulfurous acid obtained with wine fermentation in 1911[1] could be duplicated with apple juice fermentation.

TABLE I—RESULTS OF EXPERIMENTS WITH SULFUROUS ACID AND PURE YEAST IN BARREL TESTS

FERMENTATION RECORD BARREL A (NATURAL FERMENTATION)

Date	Balling	Observations
Sept. 5	16.0	Filled barrel A
Sept. 8	13.5	Fermenting vigorously
Sept. 13	5.0	Fermenting slowly
Sept. 19	3.0	Fermenting very slowly
Sept. 30	3.0	Strong "mousey" flavor: many lactic bacteria
Oct. 13	3.0	(Strong "mousey" flavor: many lactic bacteria)
Jan. 9	0.0	Still tastes sweet

FERMENTATION RECORD BARREL B (PURE YEAST AND SO_2)

Date	Balling	Observations
Sept. 5	16	Filled barrel B and added SO_2
Sept. 6	16	Racked into another barrel and added 2 per cent by volume of pure Burgundy yeast
Sept. 8	14	Fermenting vigorously; taste clean; aroma much cleaner than "A"
Sept. 30	1	Fermenting slowly; microscope shows absence of wild yeasts or bacteria of any kind
Jan. 9	0	Taste clean and dry. Much clearer than "A"

ANALYSES OF BARRELS A AND B

Sample	Balling (Brix)	Total acid as acetic	Total reducing matter as sugar	Alcohol per cent by vol.
Original juice	16.0	0.60	15.00	0.00
Barrel A Jan. 9	0.0	0.84	0.55	6.20
Barrel B Jan. 9	0.0	0.61	0.037	8.00
Barrel A Apr. 5	...	1.18	0.60	5.60
Barrel B Apr. 5	...	5.90	...	2.56

SMALL SCALE FERMENTATIONS

Two barrels of the same juice were taken. Barrel "A" was allowed to ferment naturally; barrel "B" was treated with potassium metabisulfite ($K_2S_2O_5$) at the rate of 12 oz. per 200 gallons or approximately 175 mg. SO_2 per liter. It was allowed to stand 24 hours; was then drawn off into another barrel and pure "Burgundy" wine yeast was added. A summary of the two fermentations appears in Table I and may be stated as follows:

1—Increase of 1.8 per cent alcohol.

2—More complete fermentation of sugar.

3—Elimination of wild yeasts and lactic bacteria; probably due to action of SO_2 during first 24 hours.

4—More rapid clearing of the cider and the vinegar.

5—Improved and cleaner flavor.

6—More rapid acetification after alcoholic fermentation.

30,000-GALLON FERMENTATIONS

A 30,000-gallon tank (No. 10—Table II) of apple juice was filled with juice from culls, peels and cores during a pressing period of three days. Samples were taken during filling and analyzed for Balling degree, alcohol and total acid. The juice was allowed to ferment spontaneously and was handled by methods ordinarily used in this factory.

A similar 30,000-gallon tank (No. 16) was filled with similar juice. Before going to the large tank, each 1,000 gallons as it came from the press was held temporarily in a 1,000-gallon vat and treated with 8 oz. metabisulfite per 200 gallons. This was added from a solution of 8 oz. metabisulfite per gallon in water. The first 2,000 gallons to go into the large tank were started with 100 gallons pure "Burgundy" yeast and left till next morning before any more juice was added. It took three days to fill the 30,000-gallon tank. By the time the tank was full in each case, fermentation had progressed so far that no attempt at a fermentation record was made. Table II shows the effects due to the sulfurous acid and pure yeast: gain due to pure yeast and SO_2 was found by subtracting 15.20 from 16.27 to give difference in sugar = 1.07 per cent. This was divided by 1.7 to get its alcohol volume per cent equivalent as it is considered that 1.7 per cent sugar gives 1 per cent alcohol in practice. This figure, 0.73 per cent, subtracted from 2.05 gives 1.32, the "net increase" in alcohol due to pure yeast.

The results of the large scale fermentation were satisfactory, showing a very material increase in alcohol due to pure yeast and sulfurous acid. Microscopical examination showed that the pure yeast and sulfurous acid gave a much cleaner fermentation than the natural fermentation.

TABLE II—RESULTS OF 30,000-GALLON TANK TESTS
Results in Percentages

	Tank No. 10. Natural fermentation	Tank No. 16. Pure yeast and SO_2
BEFORE FERMENTATION:		
Total solids + (alcohol × 1.7). Average of samples	15.20	16.27
AFTER FERMENTATION:		
Total acid as acetic	0.568	0.652
Volatile acid as acetic	0.160	0.108
Extract	3.70	3.60
Alcohol: Volume per cent	6.35	8.40
CALCULATIONS:		CALCULATIONS
Difference in total solids + (alcohol × 1.7) in tanks 10 and 16		1.07
Alcohol equivalent to difference in total solids		0.73
Difference in alcohol in fermented liquids		2.05
Net gain in alcohol due to pure yeast and SO_2		1.32

SUMMARY

The use of pure yeast and sulfurous acid in barrel fermentations gave increased yield of alcohol, more complete fermentation of the sugar, a better flavor, more rapid clearing, a fermented liquid practically free from lactic bacteria and *mycoderma vini*, and a more rapid change of alcohol to acetic acid after alcoholic fermentation. This indicates disappearance of practically all of the active sulfur dioxide because acetic bacteria have been shown to be very sensitive to it. Large scale fermentations with pure yeast and sulfurous acid gave an increased yield of alcohol and a cleaner fermentation. Examination of several factories shows the extreme need of some method of control of alcoholic fermentation, and to supply this need the use of small amounts of sulfurous acid to eliminate wild yeast and the addition of pure selected yeast to give a rapid and complete fermentation seems the most practical means of producing the desired results.

ENOLOGY LABORATORY, EXPERIMENT STATION
UNIVERSITY OF CALIFORNIA, BERKELEY

[1] F. T. Bioletti and W. V. Cruess, University of California Expt. Sta., *Bull.* **230**.

THE MELLON INSTITUTE OF INDUSTRIAL RESEARCH AND SCHOOL OF SPECIFIC INDUSTRIES OF THE UNIVERSITY OF PITTSBURGH

THE DEDICATION OF THE NEW BUILDING OF THE MELLON INSTITUTE

By W. A. Hamor[1]

The new $350,000 building which now forms the permanent home of the Mellon Institute of Industrial Research and School of Specific Industries of the University of Pittsburgh, was formally dedicated on February 26, 1915. This building, the gift of Messrs. Andrew William Mellon and Richard Beatty Mellon, of Pittsburgh, who consented to allow their family name—an illustrious one in the annals of Pittsburgh—to be placed upon it, possesses the strength and force characteristic of the Grecian Doric order and is distinctly modern in construction and equipment, having been especially designed by the architect, Mr. J. H. Giesey, for the needs of the Institute.[2]

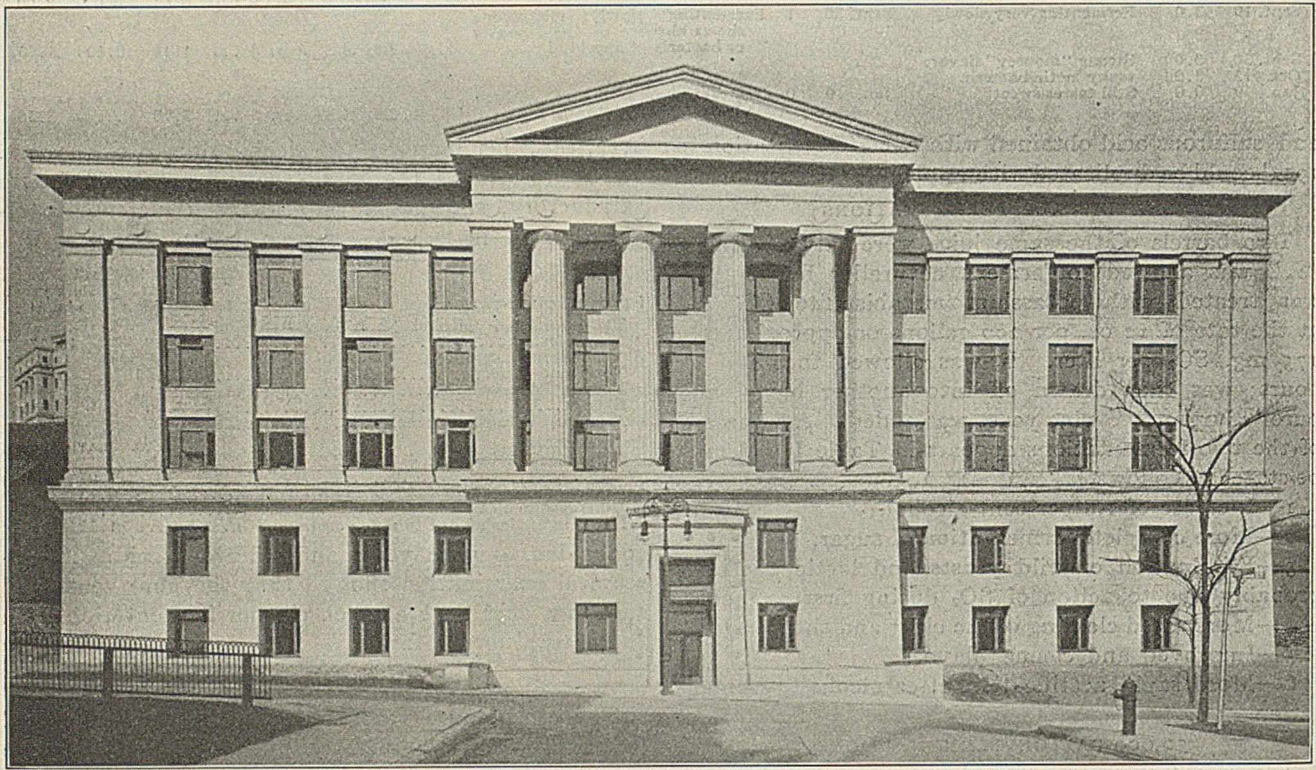


Fig. 1—The New Building of the Mellon Institute of Industrial Research and School of Specific Industries

The Chancellor of the University, Dr. Samuel Black McCormick, presided at the dedication ceremonies, which took place at 11.00 A.M. in Soldiers' Memorial Hall, in conjunction with the annual Charter Day exercises of the University. Following the address of the day by Dr. Rossiter Worthington Raymond, the dean of American mining engineers, on "Knowledge and Research," which is reprinted in full below, Dr. W. J. Holland, Director of Carnegie Museum and formerly Chancellor of the University, made the presentation speech in connection with the dedication of the Mellon Institute, on behalf of Andrew W. Mellon and Richard B. Mellon, the donors. After a brilliant eulogy of the Messrs. Mellon and a splendid tribute to their generosity, Dr. Holland said in part:

"In a certain sense, Mr. Chancellor, this building is a memorial to Robert Kennedy Duncan. On one side of the entrance is a bronze slab inscribed with the name of Thomas Mellon; on the other side of the entrance is a bronze slab inscribed with the name of Robert Kennedy Duncan. But, Mr. Chancellor, this splendid edifice erected upon the campus of our University is more than a cenotaph. It not merely commemorates the names and careers of those of whom I have spoken, but it is intended to serve as the seat of advanced inquiries along scientific lines, which will tend to the promotion not merely of intellectual culture, but of industrial success, and that not merely in this great 'workshop of the world,' where it is located, but throughout the land. In creating this institution our dear friends have been actuated by a high and intelligent purpose. Large experience in great industrial enterprises has taught them the importance of chemistry and physics in their applications to the industrial arts, and they feel that, wonderful as has been the progress made within the last century, there are untold mysteries in nature, which have not yet been revealed but which, if uncovered, are capable of being used for the welfare of mankind. And so

[1] Assistant to the Director of the Mellon Institute.

[2] See the description which follows.

they have created and are today placing in the custody of you, gentlemen of the Board of Trustees, this institution, which is capable of becoming, when wisely and intelligently administered, a mighty implement for the advancement of human welfare."

Dr. George Hubbard Clapp, President of the Board of Trustees of the University, delivered the speech of acceptance. He expressed appreciation of the gift and understanding of the importance of the work for which the building has been erected.

The final ceremony of the exercises was the conferring of fifteen honorary degrees, as follows:

DOCTOR OF LAWS

EDWARD WILLIAMS MORLEY, Honorary President of the Eighth International Congress of Applied Chemistry.

JOHN ULRIC NEF, Head of the Department of Chemistry of the University of Chicago.

ARTHUR AMOS NOYES, Professor of Theoretical Chemistry and Director of the Research Laboratory of Physical Chemistry, Massachusetts Institute of Technology.

ROSSITER WORTHINGTON RAYMOND, Secretary Emeritus of the American Institute of Mining Engineers.

IRA REMSEN, Former President and Emeritus Professor of Chemistry, Johns Hopkins University.

THEODORE WILLIAM RICHARDS, Professor of Chemistry and Director of the Gibbs Memorial Laboratory, Harvard University.

DOCTOR OF SCIENCE

JOHN JACOB ABEL, Professor of Pharmacology, Johns Hopkins University.

GEORGE HUBBARD CLAPP, President of the Pittsburgh Testing Laboratory and of the Board of Trustees of the University of Pittsburgh.

ELBERT HENRY GARY, Chairman and Chief Executive Officer of the United States Steel Corporation.

JOHN HAYS HAMMOND, Consulting Mining Engineer.

HENRY MARION HOWE, Emeritus Professor of Metallurgy, Columbia University.

DOCTOR OF CHEMICAL ENGINEERING

WILLIAM HULTZ WALKER, Professor of Chemical Engineering, Massachusetts Institute of Technology.

MILTON C. WHITAKER, Professor of Industrial and Engineering Chemistry, Columbia University.

DOCTOR OF CHEMISTRY

CHARLES LATHROP PARSONS, Chief Mineral Chemist, United States Bureau of Mines.

EDGAR FAHS SMITH, Provost University of Pennsylvania.

Immediately after the close of the dedicatory exercises, the trustees, faculty and guests of the University met at a luncheon in the University Club. The remainder of the afternoon was devoted to an inspection of the new building of the Mellon Institute.

The recipients of honorary degrees were the guests of the University at the annual alumni banquet held at the Schenley Hotel from 6.00 to 8.30 P.M. The speakers at this dinner were Dr. Raymond F. Bacon, Director of the Mellon Institute, who responded to "The Mellon Institute;" Dr. Walther Riddle, who gave an historical sketch of the department of chemistry of the University; Hon. Elbert H. Gary, Chairman of the United States Steel Corporation; Dr. Theodore William Richards, who spoke on "The Practical Use of Research in Pure Science" and extended Harvard's congratulations to Pittsburgh upon the acquisition of the Mellon Institute; and Chancellor Samuel Black McCormick, who completed the toast list with an eloquent response to "The University," in which he stated that the gift of the Mellon Institute had placed a great responsibility upon the University of Pittsburgh as well as having been a priceless acquisition; that the University was ready to meet the responsibility and, he felt sure, would show the donors and the country at large that it would make the most of the great benefaction.

Judge Gary's address was, in part, as follows:

"In humankind there is an element which is interested in, if, indeed, it does not actually enjoy reading or listening to, adverse references to the character or conduct of an individual or association of individuals, and, by reason of this fact, agencies for the collection

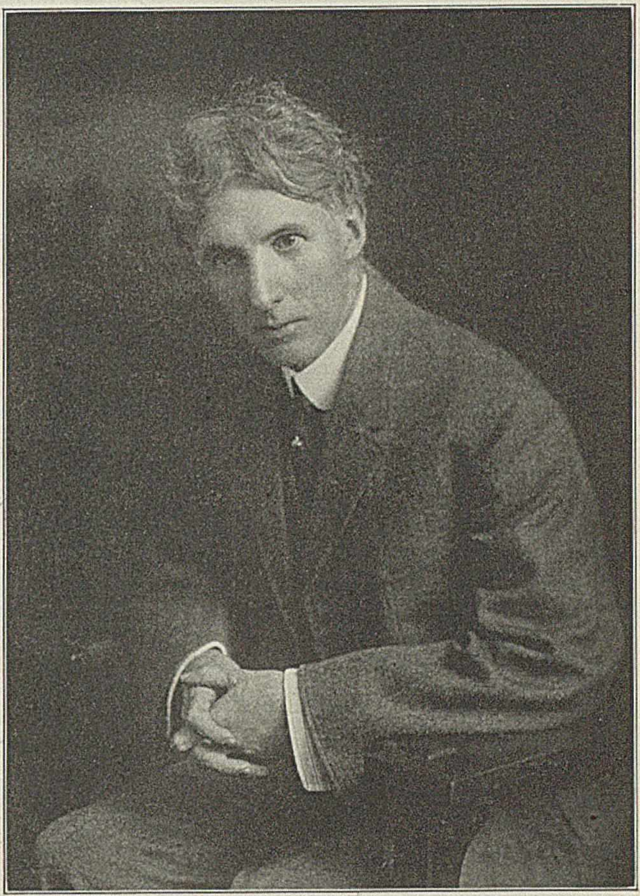


FIG. 2—THE LATE DR. ROBERT KENNEDY DUNCAN

and distribution of unfavorable comments have become more or less popular. A questionable kind of success is often realized by the individual or the publication whose energies are devoted to frequent and furious personal attack against the standing or the action of others. These efforts sometimes take the form of individual work, investigations by committees or commissions created by the Legislatures or Congresses, or, in exceptional cases, even by judicial branches of Government, such as grand juries, with their inquisitorial power. Oftentimes the investigators are not only utterly incompetent, but they are prejudiced and wilfully repress many of the pertinent and material facts. They seek to produce for circulation and criticism only information calculated to bring reproach upon the persons involved in the inquiry. No one is exempt from these criticisms.

"Circumstances seem to show that we are approaching the time when the investigator will be investigated; when the criticizer will be criticized; when committees and commissions will be brought before other similar bodies for judgment. It would be interesting to the public if it could be informed of the real motives which have prompted some of the official inquiries, and if it could learn of the unfair methods which have been sometimes pursued, and if it should know the amount of governmental funds which have been appropriated for the use of committees and how they have been disbursed; in fact, if some of those participating could be subjected to the same scrutiny which they have exercised.

"The general attitude of the great newspapers of today is fair and just. They influence and are influenced by the general public. They reflect the general sentiment. This is most important in considering the future welfare of this country.

"If the picture which I have drawn is a true one, then the course before us, which leads to prosperity, success and happiness, is plain, and we will pursue it.

Fig. 3—Raymond Foss Bacon, Ph.D., Director of the Mellon Institute

We must conduct affairs in our charge with the expectation that we shall be criticized."

After the banquet, the new building of the Mellon Institute was thrown open for a reception of friends of the Institute. The rooms of the main floor were used for the reception, although the entire building was open for inspection. On the evening of February 27th, the first Mellon Lecture was delivered by Professor John Jacob Abel, of Johns Hopkins University, in the assembly hall of the Institute; Dr. Abel's subject was "Experimental and Chemical Studies of the Blood and Their Bearing on Medicine."

KNOWLEDGE AND RESEARCH[1]

By Rossiter Worthington Raymond

This notable chapter in the history of one of the most ancient American institutions of learning irresistibly recalls the situation of 1787, the year in which the first charter of what is now the University of Pittsburgh was granted. That was the year of the Convention which framed the Federal Constitution. It was notable also as practically the beginning of two other agencies which, though derided at the time, proved afterwards to represent the most potent elements in the cementation of that solid union founded by the Constitution. For it was in 1787 that John Fitch ran his steamboat up and down the Delaware; and it was in 1787 that the fierce discussion of the improvements proposed by Noah Webster may be said to have reached its climax. That controversy resulted in Webster's Dictionary and Webster's Spelling Book, which gave us one language throughout our wide and ever wider domain. Thus the bond of political union established by the Constitution was reinforced by the beginnings of internal transportation and of a common speech, without which the growth of our continental empire would scarcely have been possible.

The wonderful changes effected in personal, social and national life during the century which ensued, would make an easy theme for any orator who might choose to tell the thrilling history of this particular region alone, beginning with the little group of cabins under the guns of Fort Pitt which constituted Pittsburgh, and tracing the conquest and rapid settlement of the Ohio valley (which was never equaled for revolutionary transformation except by the settlement of California under the special world-excitement caused by the discovery of gold), the development of commerce and industry, the accumulation of wealth, and the concomitant advance in education, culture and fullness of individual and social life. I shall not rehearse to you this familiar story, but I would point out the significance in such a sweeping torrent of change, of the things which abide.

One of these is Pittsburgh itself. Instinctively recognized, even in our colonial period, as a strategic point, to be defended at all costs, it has remained, through the astounding revolutions of its history, always the center of power and progress, demonstrating in these later days that the wealth accumulated in the service of man through smoky industries is available for man's service also in the fair fields of science and art.

And another thing that abides is the conviction of the value of knowledge which inspired our grandfathers and possesses us. They founded colleges while they

[1] Principal address delivered at the Dedication of the New Building of the Mellon Institute of Industrial Research and School of Specific Industries of the University of Pittsburgh, February 26, 1915.

FIG. 4—THE RECIPIENTS OF HONORARY DEGREES AT THE DEDICATION OF THE MELLON INSTITUTE OF INDUSTRIAL RESEARCH
Front Row, left to right: Ira Remsen, Theodore William Richards, Samuel Black McCormick, Edward Williams Morley and Arthur Amos Noyes
Middle Row, left to right: Elbert Henry Gary, Henry Marion Howe, John Jacob Abel and Milton C. Whitaker
Back Row, left to right: Charles Lathrop Parsons, Edgar Fahs Smith, John Hays Hammond and William Hultz Walker
Absent: George Hubbard Clapp, John Ulric Nef, Rossiter Worthington Raymond

were fighting Indians and leveling forests and devising governments. The progress of the world and the eminence of Pittsburgh in that progress are alike, due to science. And we Americans recall with just pride that our fathers always provided for education as a part of their social scheme. It would be absurdly superfluous, in this presence, to explain that the wonderful natural advantages of Pittsburgh would have amounted to nothing without the science which has utilized her fuel and her means of transportation. It is not manual labor alone, but, in a much greater degree, the labor of the educated brain, that creates wealth and constitutes power. And it is a peculiar characteristic of this source of power that no one can foretell the scope and value of its results. We know how many foot-pounds of energy a man or an animal can furnish in a given time; but we cannot prophesy what may be done with that energy if applied, under intelligent guidance, to the utilization of the inexhaustible forces of nature. The assertion that "knowledge is power" is an "act of faith;" but this faith has proved itself a thousand times to be well-founded. No one doubts today that the knowledge we now have is power, and must, therefore, be preserved by transmitting it to each succeeding generation—even were there nothing more to know. But we have learned also that the enlargement of the circle of things known increases the boundary beyond which lie the things yet to be known, and hence we attach a practical value to research. We need not claim for our own time alone this recognition of the importance of research. Let us modestly remember that the things we now know are the results of the research which our fathers encouraged and conducted—nay, more: that their faith in knowledge and inquiry was supported by much less evidence of valuable results than encourages us. In fact, we may be said to walk in this path, no longer by faith, but by actual sight.

Nevertheless, it is unquestionably true that the conception of university education has undergone, during the last century, an important change. Even so recently as fifty years ago, when I was a student at German universities, the traditional organization of the four faculties of Theology, Law, Medicine and Philosophy was still maintained, but "Philosophy" (originally intended to cover metaphysical subjects) had been gradually made the receptacle of everything that was not theology, law or medicine—including such trifles as mathematics, languages, literatures and sciences. And the old satire was still current: "Theology yields a man honor but not bread; law, bread but not honor; medicine, both bread and honor; and philosophy, neither bread nor honor." Yet already it was becoming evident that in the disparaged department of "Philosophy" lay the studies which were certain to yield both the bread and the honor of the future.

Today, we care little for the old classification. Our notion of a full university is that of the motto of Ezra Cornell, who founded the one which bears his name, as a place where anyone could receive instruction in anything. Towards this all-comprehensive ideal, which no institution, perhaps, has completely reached, we are all striving. And the strength, the inspiration, the fruitfulness of our development is in the increased emphasis which we lay upon research and the function which we assign to it in the modern scheme of education.

I need not make a distinction here between theoretical and practical research. There used to be a vague and uncertain attempt to divide pure science from applied science. But, in fact, they are inextricably blended. It was Sir William Thomson, afterwards Lord Kelvin, the profound student of the nature of matter, the weight and movements of worlds, whose acute genius devised the perfect mariner's compass and constructed the apparatus by which the Atlantic cable was able to transmit intelligible messages—turning industrial failure into triumph. When Thomas Edison was perfecting his great electrical inventions, he went to Ira Remsen, the distinguished teacher of pure science, for the mathematical formulas which determined the dimensions, proportions and relations of his machines. The researches of Hertz and others into what seemed at first to be a sphere of electrical disturbances beyond the reach of human analysis, have led already to the miracles of wireless communication and control—messages signaled, or even simply spoken, across oceans and continents, and boats steered by inaudible commands from the shore.

The difference between knowledge and research is the difference between the expert and the discoverer. An expert is one who knows what has been done or is provisionally established in a given science or art. He can say, with regard to a new discovery or improvement, only whether or not it contradicts or transcends what is generally accepted as the result of previous experience. But the discoverer is a prophet, and, if he has not "spoken presumptuously," his message becomes a new revelation, and a part of the science of his day—or the day after.

It seems but yesterday that I read in the newspaper how Charles Sumner, of Massachusetts, had proposed in the United States Senate an amendment to a pending appropriation bill, granting a considerable sum for the conduct of experiments in sending telegraphic messages without the employment of conducting wires. I was an expert then, and, as an expert, I knew (or thought I knew) that the thing had never been done and, therefore, was impossible. I remember reflecting how easily non-scientific people were carried away by the eloquence of fanatics or charlatans, especially when the schemes proposed were such as all the experts declared to be absurd. The common sense of the United States Senate, taking the same view, rejected the amendment; and it is my impression that the distinguished proposer of it (having, perhaps, introduced it at the request of some sanguine constituent) did not fight very hard for its adoption. It is possible that I recorded my opinion of it at the time with sarcastic humor in the columns of the technical journal of which I was editor. I have made no investigation as to that question; and, indeed, I would rather not know the answer!

At a later period, Le Conte, one of the most eminent scientific authorities in America, and one who, in his own department, and in the general exposition of the philosophy of evolution, was a leader and commander, published an essay demonstrating the theoretical, that is to say, the mathematical and irrevocable, impossibility of the navigation of the air by vehicles heavier than air. Now mathematics, as defined long ago by Benjamin Peirce, is the one science which draws necessary conclusions; but the necessity of its conclusions is simply their relation to its premises. Prof. Le Conte's judgment was based on the evidence before him. It was the utterance of Science without the testimony of Research. And already another eminent scientific authority, my dear friend and yours, Prof. Langley, long of your University, reinforcing science with research, had devised a flying-machine, heavier than air, which is now, I believe, admitted to have furnished the first solution of this problem. True, an accident not due to any unsoundness in Langley's theory and design wrecked his experimental machine, and, perhaps, broke his heart too. But time has vindicated his fame and has given us another instance of the value of scientific research to industrial progress.

But it must be real research, not merely the cloudy anticipation of things to come. Many years ago, I was visited by a "seedy" young stranger, who desired my assistance in the form of a loan which would pay his fare to Colorado, where he wished to introduce the use of electricity in metallurgy. Under cross-examination, he explained that he expected to get his electricity, Franklin-fashion, from the clouds, and, having heard that there was a good deal of it up in the Rocky Mountains, he thought Colorado was a good place for his process! If that young man has survived (which I doubt, since he did not look like a future survivor), he is doubtless saying today that he was the real inventor of the whole art of electro-metallurgy! He was a feeble specimen of the host of professional inventors who try to pre-empt territory in realms not yet explored, substituting prophetic intuition for patient and skilful research. These are the prophets who "speak presumptuously." The Book of Deuteronomy, after describing such a prophet, adds, "Thou shalt not be afraid of him." Yet, in spite of that encouraging exhortation, we are afraid of him; he hangs as an incubus upon every real inventor whose work has been based upon real research; for research is not fruitful unless it is, or until it is, scientific.

The essential quality of Science is that it is quantitative, while mere invention may be in the beginning only qualitative. After the great blizzard, more than a quarter of a century ago, a storekeeper in Brooklyn undertook to apply quantitatively the qualitative proposition that heat would melt snow. Having a 16 ft. heap of snow in front of his store and a lot of old boxes in his cellar, he dug in the snow a chamber with a chimney, crammed this stove with pine wood from the cellar, lit the fire, and looked for the mountain to dissolve in fervent heat. Being a qualitative man, he did not know the difference between temperature and heat-units, or dream of the work he was expecting his little fire to do. When he had burned all his wood, he abandoned his faith in science! Yet there is never a heavy fall of snow in New York but somebody berates the authorities for their stupidity in not thawing it away!

And this brings us to the proposition that real research must itself be based upon scientific knowledge.

There is nothing more pitiable than the spectacle of an enthusiast, fancying himself a pioneer, laboriously digging in ground already explored, exhausted and abandoned by others. My friend Clarence King told me once how he set his heart upon the ascent of a certain high peak in the Sierra. With infinite exertion, and no little peril, he scaled the precipitous mountainside, and reached at last the summit, only to find there an empty tomato can and a copy of a newspaper, relics left by a picnic party, which had ascended by an easy trail on the other side of the mountain! A little preliminary research would have saved him from this scientific fiasco.

Moreover, the careful and thorough study of science—that is, of what has been done, and has come to be believed already—will often mightily aid research with significant and invaluable suggestions; for the records of scientific experiment contain many observations which were simply noted *en passant* and left for future explanation. A distinguished electrician once said to me that, notwithstanding the amazing advance of his art, he still found in the old, simple, homely notes of Benjamin Franklin valuable hints and suggestions.

It is narrated in the biography of Sir John Lawrence, that, in 1849, after the annexation of the Punjab to the British possessions in India, the famous jewel known as the Kohinoor or "Mountain of Light,"—for many centuries the booty of successive conquerors, Turks, Moguls, Afghans, and what not—fell, with other public treasure, into the hands of the new government, represented by the Board of Administration of the Punjab, of which Lawrence was a member. At one of the early meetings of that Board, the Kohinoor was formally delivered to it, and temporarily consigned to the care of John Lawrence, perhaps because he was supposed to be the most practical and business-like of the three members. So he was, in many respects; but he had no use for jewelry, never wore it until it was forced upon him in the form of well-earned decorations—which, we are told, he used to pin on in the wrong places, to the despair of court officials—and never thought about it. So he took the Kohinoor, wrapped in numerous strips of cotton cloth, thrust it into his waistcoat pocket, and thought no more of it, while he devoted himself to the multifarious and much more important business which lay before the Board. The session over, he changed his clothes for dinner, throwing his waistcoat aside, without recalling the precious contents of its pocket. But the authorities in London were less forgetful; six weeks later came the order to forward the Kohinoor to the Queen. When this was presented to the Board, Lawrence said, "Let us send for it at once and forward it." "But you've got it," was the reply—at which a remembrance of the whole matter flashed upon him, together with the sickening certainty that the Kohinoor was not in his waistcoat pocket then! As he used to tell the story afterwards, he said to himself, "Well, this is the worst trouble I have ever yet got into!" But, with wonderful self-control, he suppressed all signs of anxiety, remarking, "Oh, yes, of course; I forgot about it," and went on with the business of the session as if nothing had happened. But at the earliest opportunity, he slipped away to his private room, and questioned his native body-servant. "Have you got a small package that I left in my waistcoat pocket some time ago?" The servant had saved it with other pocket rubbish, produced it from a battered old tin box, and, unrolling its bandages, handed the great diamond to his master, remarking, "You see, Sahib, it was nothing but a bit of glass." And thus ended a new chapter of adventure in the marvelous history of the Kohinoor.

I have told this story because of its romantic interest, and because I think it will be new to many of you, as it was to me when I came upon it in the life of the hero of the Indian mutiny, in the splendor of whose achievements even the luster of a diamond fades. But I think you will agree with me when I make of it, in harmony with its far Eastern scene, an Oriental apologue, deducing from it the moral that research, even amid the rubbish of the past, may bring to light forgotten treasure, and that a common bit of glass may prove to be a "Mountain of Light."

If knowledge and research are thus intimately related, each reinforcing the other, the manner in which they are combined in this institution must be recognized as largely novel and wholly admirable; for effective research requires suitable apparatus, and under apparatus we include books. Moreover, research is promoted by definiteness of object. The man who knows what he is looking for is more likely to make discoveries than he who merely launches into space, hoping to make discoveries through accidental collisions. And again, not only motive and apparatus and previous knowledge, but also the capacity of clear and accurate thinking, must belong to the equipment for useful research; and no man thinks accurately who cannot put his thought into words which will convey it to another man qualified by knowledge to comprehend it. We may feel, but we cannot think, unutterable things. What our patent law requires of an inventor, that his invention shall be so stated as to enable any one skilled in the existing art to practice it, is equally required of every discoverer, whether he seeks the reward of a patent or the recognition of his fellow men in other ways. He must be able to describe and to define as well as to discover.

Now, there is no discipline like that of teaching to perfect the art of precise and intelligible statement. Indeed, the teacher enjoys a continuous practice in that art which cannot be had in any other way. Our best text-books of science are the work of teachers who have learned in the classroom how to communicate knowledge. These industrial fellowships, therefore, which give to their incumbents, in addition to all the other advantages mentioned, the opportunity of practice as instructors, are likely to develop both fresh and effective teaching and fruitful research.

Moreover, such an arrangement must be welcome to the overburdened members of regular faculties of instruction, to whom the mechanical routine of teaching leaves too often neither time nor strength for that original study and progressive intellectual activity which alone can keep them sources of inspiration.

In short, the genius and wisdom of your beloved and lamented Dr. Duncan seem to me to have found a wonderful solution for a difficult problem in this scheme of industrial fellowships. May genius and wisdom still preside over its development, as they foresaw and welcomed its birth!

But this occasion emphasizes to my thought another principle, perhaps the most fundamental and far-reaching of all. In this dedication of a building erected through the intelligent munificence of private citizens, we have another instance of the method and means by which American institutions of learning, as well as of philanthropy and religion, have rapidly grown in a single century to proportions rivaling those which ancient origin, cherished traditions, and age-long growth have given to such institutions abroad. The generosity of private citizens, since the beginning of the nineteenth century, has surpassed among us all the endowments bestowed upon science and learning by the Governments of Europe in modern times, and its results may challenge a corresponding comparison. Our democratic individualism makes mistakes, no doubt; but so does paternal government. The difference is that the mistakes we make we also correct; while the mistakes of paternalism are likely to lie like a permanent, heavy blight upon progress. It is fashionable in some quarters to decry "foundations" established by private wealth; but we may challenge the critics to adduce a single instance in which, under our American system, an institution of learning or research thus supported has ever been productive of harm. Knowledge and the opportunity to pursue knowledge are the only gifts that do not pauperize the recipient. Nay, more: under free institutions and in the atmosphere of liberty, the recipient of such bounty inevitably returns it in benefaction to society. Long may it be, ere this gracious, wise and fruitful American habit of great private endowments yields to the assaults of either the demagogue or the doctrinaire!

Perhaps the chief advantage of numerous private institutions of science and research is to be found in the consequent multiplication of independent students and investigators. The victorious advance of civilization and culture is not an organized conquest, like that of a drilled and equipped army under a single head. It is rather like the free, yet invincible, advance of the forest over denuded areas—each tree sending forth its seeds, wind-blown, each seed fighting its own battle with heat and cold or vigorous competitors, and the victorious survivors constituting the forest of the future. Apart from all considerations of government or statesmanship, I thank God for the numerous separate States of our Union, and for the numerous independent institutions in each State which permit the testing of new propositions in science, industry, politics, sociology or statesmanship on a working scale not fatally extensive.

Finally, let me congratulate the University of Pittsburgh upon its retention of the old College course as the center of its wide modern activities. As a member of a technical profession, I place the highest value upon that liberal preparation which, in my judgment, is still the best foundation for usefulness and success in any specialty of modern training.

The Cooper Union of Science and Art, organized in New York more than half a century ago, was primarily intended by Peter Cooper to give to working men and women whatever they most needed for the immediate satisfaction of their conscious desires and the immediate increase of their wage-earning power, or, in other words, their value to the community. Having been connected with that pioneer institution in one way or another for twenty years, I can testify that this original purpose was at all times respected by its Trustees. They rated the importance of each special department by the pressure of applicants. In this respect, they were like the old "paradoxer" of whom De Morgan tells, who, after many failures in obtaining a comfortable chair, at last procured a large lump of shoemaker's wax, sat on it for several hours, and then gave it to the cabinet-maker with the terse injunction, "Make me a chair with a bottom like that!" In other words, they let the pressure of public demand determine their supply of special facilities; and sometimes, while they were still (as I trust they are no longer) obliged by insufficiency of means to curtail one department if they enlarged another, this policy compelled them to sacrifice courses of instruction good in themselves and needed to complete the symmetry of their plan, but not patronized by students in proportion to their cost in money and room. Yet through all these years of compromise between curriculum and immediate popular demand, the Trustees of the Cooper Union maintained, for those who chose, and could afford to take it, the regular, old-fashioned, four years' liberal college course. For they felt that while they ought to furnish to those who had not enjoyed the opportunity of a thorough education such partial substitutes as circumstances would permit, it was equally their duty to hold up as the ideal a completer culture, embracing the wisdom of the past, as well as the special accomplishments demanded by the present.

Alas! While we thus launch in hope another stately ship of peace, bearing blessings to our children and our children's children, the nations are building and sailing and sinking battleships, the cost of one of which would establish a great university. War is squandering recklessly the inheritance of centuries, and burdening with intolerable loss and labor a generation of orphaned paupers. Is this the triumph of science and research, to devise new kinds of murder? Have we conquered the domain of the sky, only to drop from it the thunderbolts of reckless hate? Do we navigate the depths of the sea, only that we may suddenly wreck, without warning, the unsuspecting sailors on its surface? Is this the highest achievement of our chemistry—to make explosives which will poison while they mutilate? And have centuries of mechanical and metallurgical progress enabled us only to construct guns which will carry our horrible missiles further than we can see our targets, so that we kill according to trigonometrical calculations made for us by surveyors in the air above us?

The spectacle of such an unparalleled world-catastrophe reminds us indeed of the grim old truth that, while "knowledge is power," power itself has no moral quality, and may be equally useful, for the time being, though not for ultimate results, to the workers of evil and the workers of good. Yet this we knew before, and with it the world has had to deal at every step in the slow advance of the sense of human brotherhood. History has recorded many world-catastrophes. Over and over again, power has wrought ruin, which seemed to be final and irreparable. Yet over and over again the darkened earth has emerged from the shadow which seemed to be death, but was only eclipse. Let us have faith, born of experience, in the solar system!

Many years ago, at a banquet of the American Institute of Mining Engineers in Pittsburgh, Prof. Langley made an exquisitely graceful speech, in which he described a vision he had seen. That was in the early days of natural gas in Pittsburgh. The great iron and steel works had not yet universally adopted its use, and the black smoke from innumerable chimneys still enveloped the city. But everybody was prophesying and hoping great things from this gaseous fuel; and Prof. Langley's vision was that of a regenerated, clean, sootless Pittsburgh—radiant angel of a happy industry.

Well, the vision became a fact. For a period all too brief, Pittsburgh, burning natural gas, was clean—that is to say, reasonably so, to her great pride and delight, and to the great comfort of her visiting guests. But natural gas grew scarcer and dearer, and the furnaces went back to coal, and the black pall descended again upon the great city. Was there no cure, no hope of a higher, purer life for the thousands who toiled in grime and darkness? Behold the answer in this higher Pittsburgh, in the midst of which we stand!

May we not make of this homely history a parable and a prophecy? Did we not dream of a purer atmosphere for all mankind? Had we not seen already upon the mountains the beautiful feet of the dawn of that happy day? And now that the war-cloud, blacker than ever, has descended upon us, let us still look forward, with unfaltering faith, to the ultimate fulfilment of our hopes, our labors and our prayers in a New White World!

DESCRIPTION OF THE NEW BUILDING OF THE MELLON INSTITUTE[1]

By W. A. Hamor[2]

It may first be noted that the plan of the new building which now forms the permanent home of the Mellon Institute of Industrial Research and School of Specific Industries, was laid down in accordance with the destiny of the Institution, as judged by its past, its immediate demands and the probable development within the next half-century. Over the doorway of the new edifice, in bronze, is this inscription: "This Building is dedicated to the service of American Industry and to young men who destine their lifework to the Industries, the goal being Ideal Industry, which will give to all broader opportunities for purposeful lives." This inscription gives an excellent idea of the purpose for which the building has been erected.

Secondly, in the design, erection and equipment of the building, three basic considerations, all very closely related and having to do with efficiency and economy, have been borne in mind. These are, in the order of their importance: research, engineering and administration.

Since the building was designed primarily as an industrial problem workshop, some of the factors which were involved in its construction from this viewpoint are presented rather fully below, in the first section of this paper, owing to the growing appreciation of the value of industrial research. A detailed account of the construction is given in the section entitled Engineering Details; it may be mentioned here, however, that the building is in harmony with the architectural features of the others on the University of Pittsburgh campus.

RESEARCH CONSIDERATIONS

The ground plan of this five story and attic laboratory building was laid out to secure the greatest amount of light, air and compactness. The basement contains seven rooms: the main storeroom, the boiler room, the electric furnace room, a heavy apparatus room, a room equipped for low-temperature work, the machine shop, and a kitchen. On the first, the main, floor, are located the general office, the Director's suite, the office of the editorial department, the library, the office and laboratory of the Assistant Directors, the Assembly Hall, a special apparatus room, and a dark-room laboratory. The second and third floors each contain ten large research laboratories and nine small ones; the fourth floor, which is not finished, will contain an identical number of laboratories as soon as the growth of the Institute warrants its completion.

The facilities which the Mellon Institute now offers for research are primarily instanced in its

RESEARCH LABORATORIES

In general, there are two sizes of research laboratories for the use of the Fellows of the Institute; twenty laboratories 20 ft. 6 in. x 20 ft. 6 in. and eighteen laboratories 10 ft. 6 in. x 20 ft. 6 in., on the second and third floors, have been finished and assigned. This number will later be increased by ten large laboratories and nine small ones on the fourth floor. All laboratories are connected with the general office by an electric call-bell.[1]

The laboratories are not too deep for good light throughout from without. To ensure the latter, the ceiling on the second floor was made 10 ft. 8 in. in the clear from the floor; on the third and fourth floors, the ceilings are 10 ft. 2 in. above the floors.

[1] Published with the approval of Dr. Raymond F. Bacon, Director of the Mellon Institute.

[2] Assistant to the Director of the Mellon Institute.

[1] See Electric Wiring System in the section on Engineering Details, *infra*. A telephone is conveniently located in each of the corridors.

LABORATORY TABLES—The laboratory table tops, which are supported on pipe standards, and are 3 ft. 1 in. clear from the floors and 2 ft. wide, are constructed throughout the building of alberene stone, 2 in. in thickness. All table tops have a $^1/_4$-in. slope to the back, with a 3-in. gutter, cut in the top, having a fall to the sinks; and there is a drip cut in the underside of each, on the outer edge, to prevent dripping. Each table is equipped with four sets of gas, water, vacuum, and compressed air supplies; the water outlets are $^1/_2$ in., all others are $^3/_8$ in. On each table there is an alberene stone back, 14 in. high and $1^1/_4$ in. thick; this is equipped with A. C. and D. C. plugs.

Above the tables are two alberene shelves, $1^1/_4$ in. thick x 7 in. wide, and a top shelf, 12 in. wide; the shelves are spaced 14, 10, and 12 in., respectively, and are supported on alberene stone slab-brackets, with a curved front at the top to meet the 12-in. shelf.

In each large laboratory there are nine sections of one large and two small drawers each, with a compartment underneath, provided with double doors, fitted with friction catches and wooden knobs. In the small laboratories there are eight sections of drawers.

The cupboards or cases on the first floor are made of quarter-sawed white oak; on all other floors the construction is of plain-sawed red oak.

HOODS—All laboratories, large and small, are provided with one double hood, 6 ft. long over all, constructed of alberene stone; the inside measurements are: 1 ft. 6 in. deep x 5 ft. 8 in. long x 4 ft. 3 in. high. Each hood is equipped with two sliding sashes, glazed with polished plate wire-glass; the sashes are suspended on bronze sash chains and are balanced with lead weights. At the end of each hood is a light of polished plate wire-glass, 12 x 26 in.

In each hood there are an A. C. plug, gas, water, steam, vacuum, and compressed air outlets. In one end of every hood a 3-in. opening connects with the hood-ventilating system.[1]

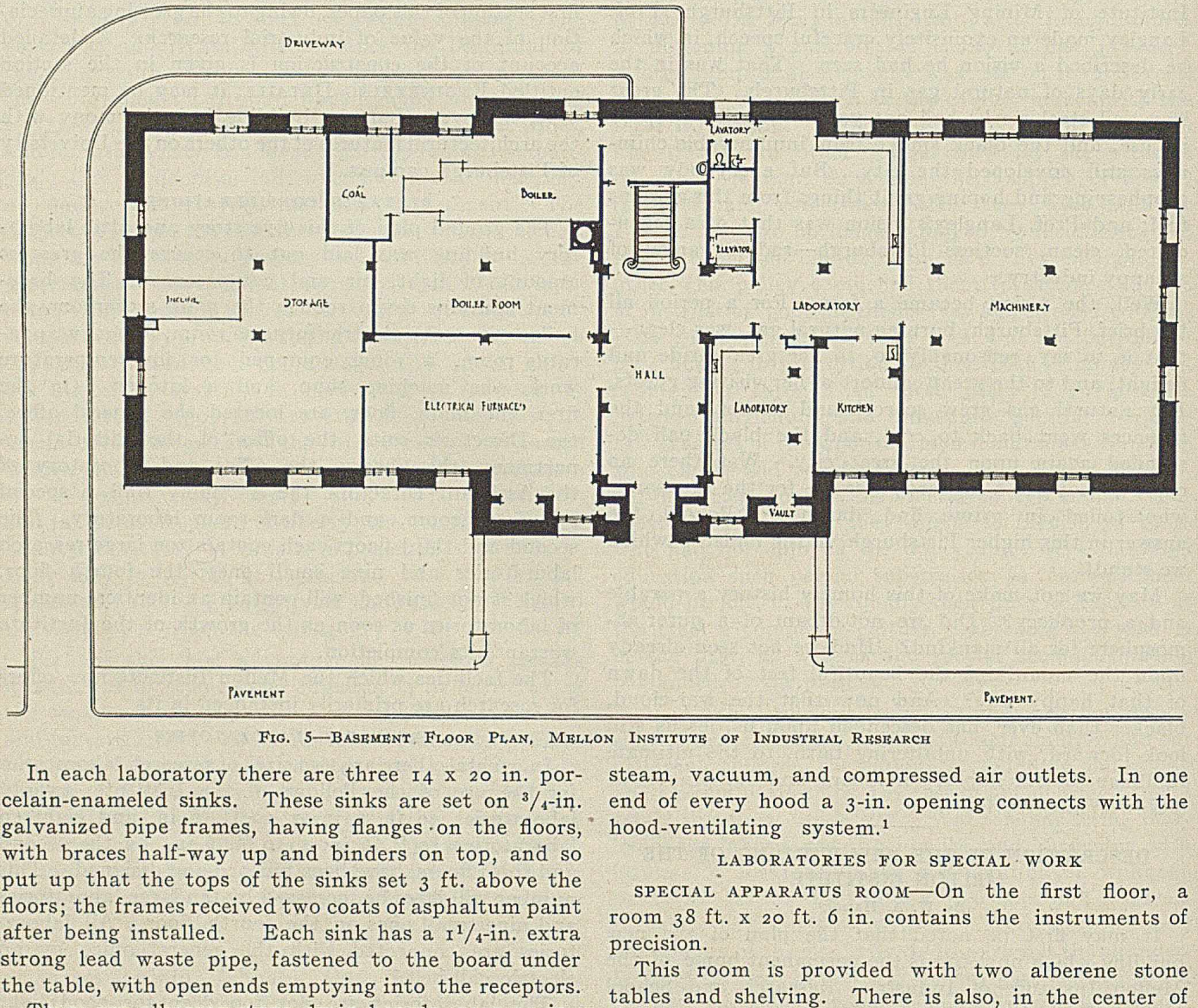


FIG. 5—BASEMENT FLOOR PLAN, MELLON INSTITUTE OF INDUSTRIAL RESEARCH

In each laboratory there are three 14 x 20 in. porcelain-enameled sinks. These sinks are set on $^3/_4$-in. galvanized pipe frames, having flanges on the floors, with braces half-way up and binders on top, and so put up that the tops of the sinks set 3 ft. above the floors; the frames received two coats of asphaltum paint after being installed. Each sink has a $1^1/_4$-in. extra strong lead waste pipe, fastened to the board under the table, with open ends emptying into the receptors.

There are alberene stone drain boards, 20 x 39 in., back of each sink; these boards are equipped with rubber-tipped wooden pegs. There is also one set of gas, water, vacuum, and compressed air lines over each sink.[1]

[1] For a detailed description of the cold water lines, hot water system, and vacuum and compressed systems, see the account of the PLUMBING under ENGINEERING DETAILS, *infra*.

LABORATORIES FOR SPECIAL WORK

SPECIAL APPARATUS ROOM—On the first floor, a room 38 ft. x 20 ft. 6 in. contains the instruments of precision.

This room is provided with two alberene stone tables and shelving. There is also, in the center of the room, a raised platform, 12 x 18 ft., of reinforced concrete supported on reinforced concrete columns extending down through the basement, with separate footings underneath the columns; this platform and its supporting columns are so arranged that they do

[1] See PLUMBING in the section on ENGINEERING DETAILS, *infra*.

not come in contact with any portion of the building construction, there being a $^1/_2$-in. space around the columns at both floors. A fire-proof vault, 2 ft. 6 in. x 9 ft., is provided for the storage of platinum ware, radium preparations, and other valuable equipment for research.

HEAVY APPARATUS ROOM—The 23 x 33 ft. room adjoining the kitchen in the basement, just off the hall, is equipped with two laboratory tables and with systems of grinding and pulverizing machinery and filter presses.

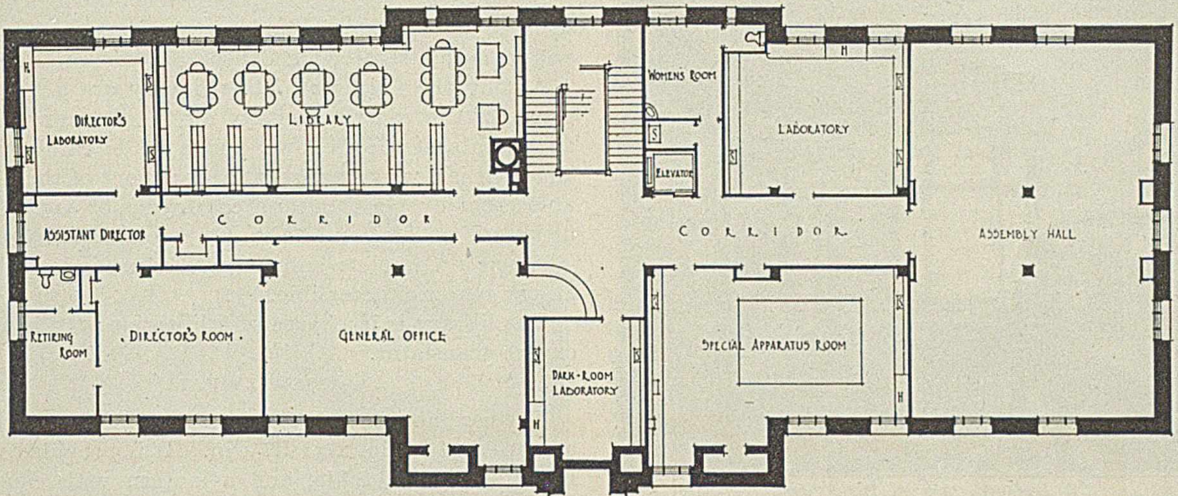


FIG. 6—FIRST FLOOR PLAN, MELLON INSTITUTE OF INDUSTRIAL RESEARCH

DARK-ROOM LABORATORY—A special dark-room, 16 ft. 4 in. x 18 ft., has been provided on the first floor for work in photography and for photochemical research. It is equipped with two alberene stone work-benches and a hood.

ELECTRIC FURNACE ROOM—A basement room, 20 ft. 6 in. x 37 ft., is fitted up for electric furnace work. There are four power outlets in the floor, and two induction regulators and the important types of electric furnaces are installed.

REFRIGERATING PLANT—A No. 3 Audiffren-Singrun refrigerating machine, having a cooling effect of 40 lbs. per hr., an ice-making capacity of 27 lbs. per hr., requiring 95 lbs. of condensing water at 70° F. per hr. and 1 to $1^1/_4$ H.P., and possessing a speed of 280 R.P.M., is located in the basement in a room 14 ft. 6 in. x 20 ft. 6 in. Adjoining this machine is a cork-lined cold-storage room, 6 x 8 x 7 ft., provided with storage shelves and a bench. The machine is guaranteed to keep this room at 37° F. and to make 50 lbs. of ice per day in summer.

SUPPLIES

THE MAIN STOREROOM, 34 ft. 8 in. x 51 ft. 4 in., is located in the basement. It is furnished with an installation of steel shelving having a total shelf surface of 3,200 sq. ft.; the greater portion of this equipment is shelving, the remainder consisting of 96 bins carrying a volume of 1,070 cu. ft. and six double cupboards having a volume of 114 cu. ft. Special provision is made at the ends of the cases for metal racks to care for all glass tubing and rodding. All shelving is finished in acid-proof baked enamel.

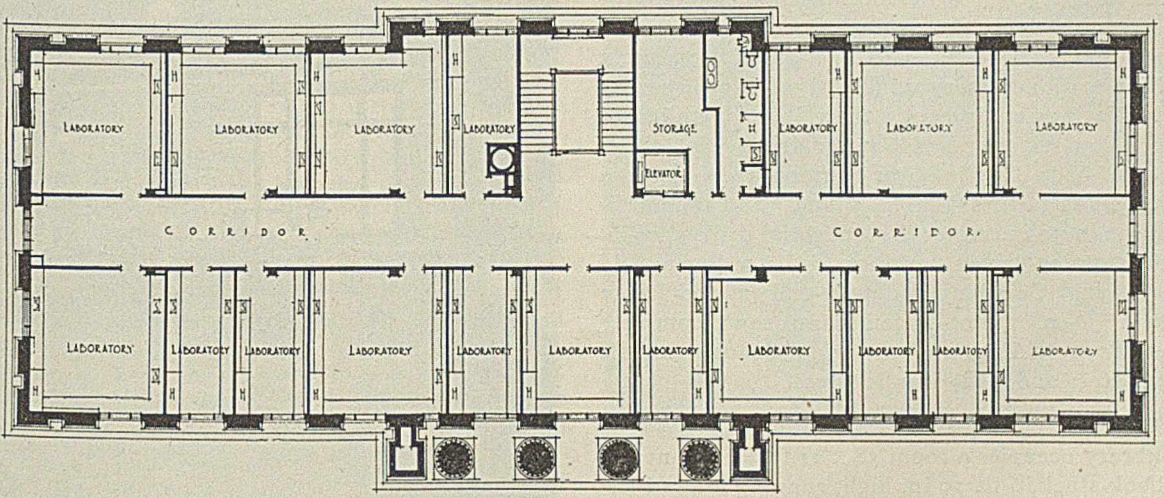


FIG. 7—SECOND AND THIRD FLOOR PLAN, MELLON INSTITUTE OF INDUSTRIAL RESEARCH

The storeroom is in charge of a curator of supplies whose sole duty is to tend the stock and order materials required by the thirty-eight Fellows now engaged in research. It is in telephonic communication with each floor of the building, and a dumb-waiter, capable of lifting 50 lbs., has been installed for distributing small supplies.

DISTILLED WATER—A Barnstead automatic water still, having a capacity of 5 gals. per hr., is installed in the attic of the building. The distilled water storage tank has a capacity of 125 gals.; it is constructed of No. 16 gauge galvanized iron, lined throughout with pure block-tin, and is furnished with a tin-lined cover.

FIG. 8—INTERIOR VIEW OF TYPICAL SMALL RESEARCH LABORATORY
Eighteen Laboratories of This General Type Are Finished and Assigned

There are six distilled-water fountains throughout the building; five of these are in the corridors and one in the general office. The fountains are supplied by gravity from the storage tank in the attic, through a $^3/_4$-in. main of block-tin pipes, with $^1/_2$-in. block-tin branches to each fountain.

MACHINE SHOP

The machine shop occupies one-half of a room 51 ft. 4 in. x 40 ft. 4 in. in the basement. At the present time it is in charge of two skilled mechanicians and is equipped to produce the various special mechanical appliances likely to be required in industrial research. In addition to all necessary small tools and to carpentry and pipe-fitting equipment, there are installed a Lodge-Shipley selective-head motor-driven[1] lathe, 22 in. x 14 ft. bed; a 12-in. Star motor-driven lathe; a 20-in. Cincinnati motor-driven shaper; a Cincinnati-Bickford plain 30-in. motor-driven radial drill; a 14-in. Washburn motor-driven sensitive drill; a Springfield Manufacturing Company's double-end motor-driven grinder; a 36-in. motor-driven band saw; complete oxy-acetylene welding apparatus; a Schoop metals coating pistol; and a hydraulic press.

LIBRARY

The library occupies a room 58 x 21 ft. It contains a unit book-stack, 6 ft. 10 in. high, running around the room, which forms adjustable shelves, 10 in. deep; and seven book-stacks running out 6 ft. from the wall. The latter stacks are double, each side having a depth of 8 in., and the total shelf capacity is about 12,000 volumes. Opposite the stacks and along the windowed side of the room are four reading tables, 3 x 5 ft., with four arm-chairs at each. There is also a larger table, 3 ft. 6 in. x 8 ft., for periodical reading, at which table eight people may be seated comfortably at one time. This table faces shelves containing 72 technical periodicals which are received currently by the library. All the woodwork and furniture in the room are solid antique oak.

At present the library possesses 2,000 carefully selected volumes, not including government publications and pamphlets, of which there are several thousand.

Among the features of this library are a file of reprints of the contributions of all the Fellows, a file of all patents of the Fellows, and a trade catalogue file. This last is a very important department of the library; at present over a thousand catalogues of 415 different firms are on file, and this number is added to, daily. There is a complete subject and name index, making all the material accessible.

The library is in charge of a librarian who is also an expert translator.

ASSEMBLY HALL

The assembly hall, located on the first floor, occupies a space 34 ft. 3 in. x 51 ft. 4 in. It is provided with a movable lecture table, and a lantern with cinematograph attachment is installed in the mezzanine floor in the first floor corridor adjacent to the hall.

This hall is used for seminar work and staff meetings, and as the lecture room of the School of Specific Industries. Its walls are decorated with photographs of eminent chemists and with pennants of the various universities represented on the staff, presented by the Fellows in pledge of their fidelity to the ideals of the Institute.

CORRIDORS

The corridors on the second and third, the research laboratory floors, are 10 ft. wide and 161 ft. 6 in. long.

FIG. 9—INTERIOR VIEW OF TYPICAL LARGE RESEARCH LABORATORY
Twenty Laboratories of This General Type Are Finished and Assigned

A dumb-waiter shaft from the basement to the attic has an opening at the end of the corridor on each floor. There are also two drinking fountains, supplied with distilled water, and a telephone in each corridor.

[1] A floor box for power and light outlets is installed at each machine.

Medicine chests, provided with the ordinary emergency equipment, and fire-extinguishing apparatus are conveniently located in each corridor.

ENGINEERING DETAILS[1]

There are a number of technical features in this, the most modern research laboratory in this country, if not the world. Reference will be made to certain of these during the course of the following account of the construction of the building, which is made rather detailed for the special use of ones contemplating or engaged in the erection of similar buildings.

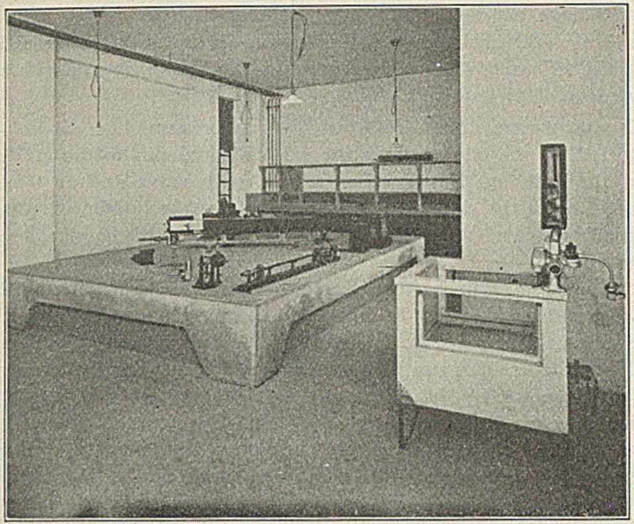


FIG. 10—SPECIAL APPARATUS ROOM, SHOWING RAISED CONCRETE PLATFORM

EXTERIOR CONSTRUCTION

The basement and first story facing, entrance, stylobate, mould, columns and pilaster bases and caps, and lintels were worked from white granite. All exposed granite has 8-cut surface; the granite facings have a 4-in. bed and are anchored to the backing with $^1/_4$ in. × $1^1/_2$ in. galvanized iron anchors, one to each piece smaller than 3 ft. and two to each piece larger than 3 ft.; the joints have a uniform width of $^3/_8$ in. At the time of setting, the joints were left open to a depth of $^3/_4$ in.; after setting had been completed, they were pointed with white non-staining cement mortar composed of one part cement and two parts Ligonier limestone dust. All granite was set in mortar composed of one part cement and three parts sand.

The interior walls, backing-up of granite, exterior walls and flues were laid up with common brick with $^3/_8$-in. joints. The exterior walls above the granite were faced with wire-cut vitrified brick of a uniform ivory-white color. The insides of all exterior walls were lined with hollow brick.

The smoke flue was lined, from the flue holes in the basement to a point 25 ft. above, with fire-brick laid in fire-clay mortar; from this point to the top it was lined with a special flue lining. "Tee" joint outlets were placed in salt-glazed sewer pipe vent flues, to connect with hoods in the various laboratories; these vent flue pipes are extended to the attic and are there connected to a large ventilating fan which effectively removes all fumes from the hoods and rooms. All joints were made with a mixture of kaolin and asphalt.

It may be mentioned in this connection that the partitions were laid, as usual in buildings of such construction, with hollow fire-proof blocks, to which the wood door bucks were anchored with six $^3/_8$-in. round steel anchors to each opening.

[1] Mr. J. H. Giesey, the architect of the building, has courteously supplied much of the information which is given in this section.

ROOFING

The roofing is of 16-oz. soft copper, laid on one layer of tomb brand felt $^1/_8$ in. thick, weighing about 2 lbs. per sq. yd.; the felt is so laid that all joints are under the wood ribs. The latter are $1^3/_4$ × 3 in., with sides beveled to allow for the expansion of the copper; they are set $22^3/_4$ in. on centers to suit copper 24 in. wide. Copper cleats are placed 15 in. on centers, nailed to wood strips and double-seamed in with the roofing proper and copper strips covering the wood ribs. The cross seams are $^1/_2$ in. single-locked and are well soldered on both sides. At the bottom or gutter line the ribs extend over the gutter $^5/_8$ in. or even with the outstanding edge to which the roofing is attached; the gutter is lined with 16-oz. copper. The outlets are 8 × 8 in. with No. 12 copper wire baskets standing up at least 4 in. above the bottom of the gutter. The eave pipes from the gutter extending 18 in. into the galvanized iron conductor pipe, are exposed in the attic space to prevent freezing.

The projecting courses at the base of the columns and pilasters around the building are covered with 16-oz. C. R. copper, laid on felt, the lower one formed to make a decided drip at the bottom, outer edge, and to run under the next course. The capitals of the columns and pilasters are covered with 24-oz. C. R. copper, formed so as to lie down closely from the weight of the course of granite above; the outer edge is doubled and bent out to form a drip at an angle of 45°. The top of the main entrance door head is also covered with 24-oz. C. R. copper; it has a small drip gutter at each side, so arranged as to form a drip at each outer corner. All sills are covered with C. R. copper $^1/_8$ in. thick, formed with drip at the outer edge and with the back edge turned up into a groove in the wood sub-sill of the frame. 4 × 8 in. vent registers are placed in the attic walls and No. 14 $^1/_2$-in. mesh copper gratings are placed in the soffit of the cornice over perforated rosettes.

PLUMBING

MAIN SEWER—A 10-in. terra-cotta sewer, connected to the main sewer on the sidewalk, is run to each receptor, leaving a connection for the house sewer on the sewer side of the receptor. Two receptors, made of 30-in. terra-cotta pipe set on a 6-in. concrete base and having a 6-in. wall of concrete around same, were erected outside of the building; each receptor was provided with a heavy cast-iron perforated lid set flush with the finished grade. The bottom of each receptor is covered by a circular glass disk 1 in. thick. The 10-in. sewer and the 6-in. conductor sewer have terra-cotta well traps in the

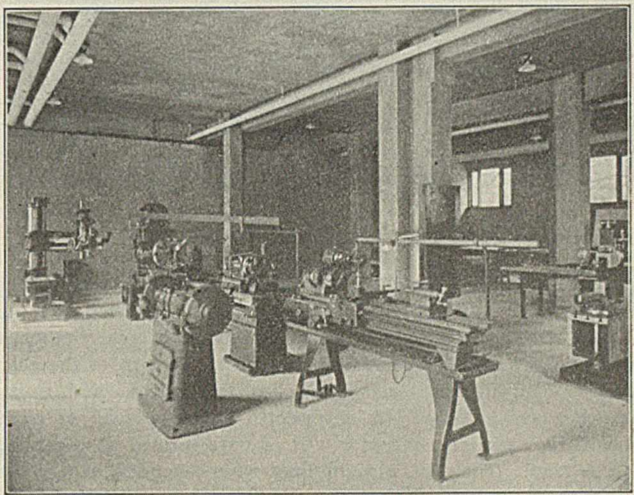


FIG. 11—A VIEW IN THE MACHINE SHOP

receptor set so as to form a seal. The 6-in. acid drains are connected with open ends to the receptors.

CONDUCTOR DRAINS—From each conductor well trap in the receptors a 6-in. terra-cotta sewer was run to 5 ft. from the building, and then a 6-in. extra heavy cast-iron sewer to connect only to the four conductors and French drains; these conductors have no traps at the bottom of the upright lines. The upright lines are constructed of 5-in. galvanized pipe with galvanized drainage fittings, and have copper sleeves at roof gutters, extended at least 18 in. into the galvanized pipe. The upright lines are concealed in recesses in the walls of the finished rooms.

SOIL DRAINS—A terra-cotta sewer, with house trap and fresh air vent, connected to the 10-in. sewer outside of the receptor, was run to 5 ft. from the wall, from which an extra heavy cast-iron sewer with branches was run, to connect with the bell traps, sinks, slop sinks, washstands, shower baths, etc. All joints were caulked with oakum and molten lead, and were tested with water.

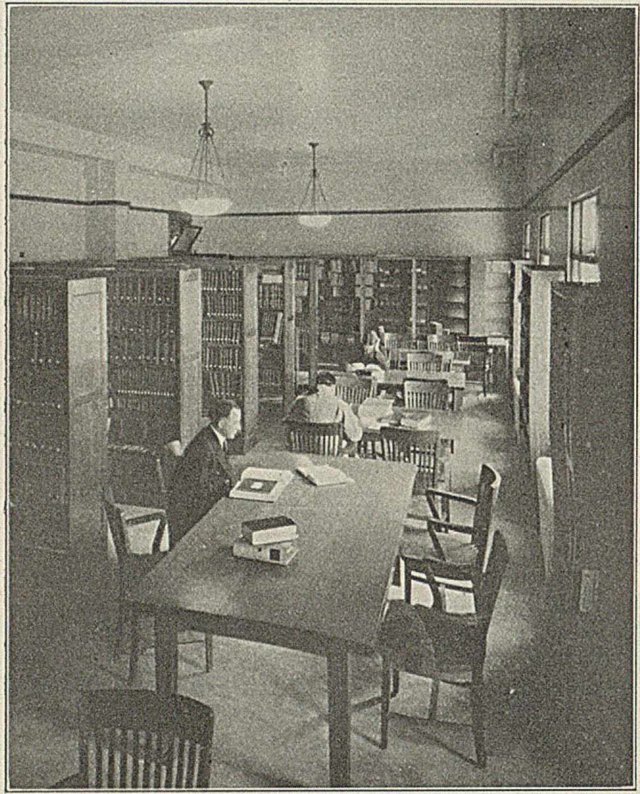


FIG. 12—THE LIBRARY

ACID DRAINS—Six-in. terra-cotta sewers with 4-in. branches were connected to the receptors and run to connect to the acid drains. The upright lines are 3-in. terra-cotta, with 3-in. branches and with a 3-in. terra-cotta P-trap placed at each riser with a concrete receptor 1 ft. square formed at the inlet of the trap. The 3-in. upright lines were extended to a point 1 ft. above the attic floor, leaving 3-in. openings on the fourth and attic floors for future use. From this point the 3-in. upright lines were gathered into four 8-in. extra heavy cast-iron lines and extended through the roof 6 in. on the high side, for the acid drain vent. These 8-in. lines were placed so as to have one-fourth of the vent lines connected to each one, and the lines connecting same were 4 in. for two 3-in. lines, 5 in. for three 3-in. lines, 6 in. for four 3-in. lines, and 8 in. for six 3-in. lines. These lines were suspended from the ceilings by approved pipe hangers every 5 ft. Where the 8-in. vents pass through the roof, heavy copper flashing the same height as the pipe was used. After the flashing had been put on, a piece of 8-in. pipe 6 in. long, with bowl down and securely cemented joints, was placed on top of both. All pipe for the acid drains from the receptor to 1 ft. above the attic floor level was laid in concrete. All concrete casings around the pipes above ground were reinforced with four $^1/_2$-in. twisted rods; these rods were wired against the bowl of the pipe with $^1/_8$-in. wire. All horizontal lines have not less than $^1/_4$-in. fall to 1 ft. All upright lines had a $^1/_4$-in. thick asbestos washer laid in the bowl for the end of the adjoining pipe to rest on, and all joints were made with a mixture of asphalt and kaolin.

COLD WATER LINES—A 4-in. cast-iron pressure line was connected to the city main in the sidewalk and run to the inside of the building; this line has a 4-in. gate valve and an 8-in. gate box in the sidewalk. On the inside of the building a 3-in. iron body gate valve was installed on each side of the 3-in. disc meter.

All cold water lines in the basement are wrought-iron galvanized pipe with galvanized fittings. The branches are as follows: From the meter a 3-in. line runs to the boiler room, and from this line 2-in. lines run to where the risers go up for the laboratory lines. A $1^1/_4$-in. line is run to the storage heater, a 1-in. line to each heating boiler, a $1^1/_4$-in. line for the basement toilet, and, for risers to supply the upper toilet room, this line is run to the attic, a $^3/_4$-in. connection being made for the expansion tank. A $1^1/_2$-in. line is run to the heavy apparatus room, and from this line a $^1/_2$-in. connection is taken to each of the laboratory sinks in the basement and to the sinks which receive the waste from the drinking fountains.

Three-fourths in. galvanized lines, connected to cellar lines in the basement, are run to the inside of the wall where the hose connections are located; at this point, a $^3/_4$-in. compression stop and waste cock is placed, and a $^3/_4$-in. extra strong lead line is run 3 ft. 6 in. under ground to each of the four street washers at the outside of the building.

HOT WATER—There is installed a 300-gal. per hr. storage heater, having 140 ft. of $^3/_4$-in. copper coil, connected to a 250-gal. extra heavy tank; the heater is connected with brass circulators and is provided with a thermometer, pop safety-valve, gate valve near the boiler, indicating thermostat, $^3/_4$-in. drain cock, and gate valve on both hot and cold water lines near the boiler. The boiler is set on a brick foundation 3 ft. 3 in. square $\times$ 9 in. high and is covered with a $1^1/_2$-in. coat of 85 per cent magnesia covering and a canvas jacket.

A $1^1/_4$-in. line, connected to the storage boiler, is run to the branch for the washstand and slop sink on the first floor, and a 1-in. branch to the risers for the toilet room, with a $^3/_4$-in. line to the washstand in the basement and to the Director's toilet on the first floor. All hot water pipes in the basement are galvanized iron suspended on hangers. A 1-in. brass riser runs up through the toilet room, exposed to the fourth floor, and a $^3/_4$-in. brass return line to the basement, with a 1-in. line of galvanized iron pipe from the bottom of the brass return line to the boiler, with gate valve and check valve. From the 1-in. brass riser branches were taken as follows: $^1/_2$ in. to washstands, $^1/_2$ in. to slop sinks, $^3/_4$ in. to shower baths. All the pipe in the toilet rooms is brass, exposed, and each fixture has a separate compression stop. All cold water lines for the toilet rooms above the basement ceiling are brass pipe and are of the same size as the hot water lines.

GAS FITTING—Starting at a point near the water-meter a 3-in. natural gas line is run to the boiler room, a 2-in. line being taken off to the heavy apparatus room, a 1-in. branch to the storage boiler, a 1-in. branch to the live-steam boiler, and a 2-in. branch to where the risers go up to the laboratory lines connecting the 1-in. and the $1^1/_4$-in. risers. All gas pipes in the basement are black pipe with galvanized fittings.

VACUUM AND COMPRESSED AIR—A National air compressor with a 14-in. air cylinder and 12-in. stroke, rated at 321 cu. ft. of air per min. at 150 R. P. M., is installed in the boiler room. This compressor is run by a 40 H. P. rating motor run at a speed not exceeding 900 R. P. M. The motor is connected with a noiseless metal belt and is set on an extension of the metal base for the compressor; both are set on a concrete base. The motor is for 110 volts A. C. 60 cycles, 3-phase current, and is equipped with knife-switch and starting box mounted near by. Near the compressor are installed two 275-gal. black iron tanks, set upright, with $^1/_4$-in. shell and $^3/_8$-in. heads. These tanks have hand-holes at the bottom and are provided with openings to connect to the air compressor, since one tank is used for a vacuum tank and the other as an air storage tank. The air tank has a safety valve set at 30 lbs. pressure, and the line from the vacuum tank has a 3-in. brass check valve and a 3-in. regulating valve set to allow air to feed through the pump when the pressure drops below 25 lbs. on the air tank; the air tank is equipped with an air gauge and the vacuum tank has a gauge to show the vacuum on the tank. From the air and vacuum tanks, lines of galvanized pipe are run to connect the risers to the laboratories; 1-in. lines with $^1/_2$-in. connection also run to all rooms used as laboratories in the basement and first floor.

GAS, VACUUM, AIR AND WATER RISERS—Three sets of risers for gas, vacuum, air and water, exposed and of galvanized iron, are run to 1 ft. above the fourth floor. All exposed pipe running through the walls and floors in the building are run through No. 14 gauge galvanized sleeves with slip flanges on each end; the floor sleeves extend 1 in. above the finished floor. These sleeves were fastened to the concrete forms before the floor was put in. The sizes of the front risers supplying the rooms in the front part of the building are as follows: To connections for second floor gas, vacuum and air $1^1/_4$ in., and water $1^1/_2$ in.; to supply third floor gas, vacuum and air 1 in., and water $1^1/_4$ in.; the ends which run up 1 ft. above the fourth floor being gas, vacuum and air $^3/_4$ in., and water 1 in. The risers to supply the rear rooms to the right and left of the stair hall are of the same kind of pipe and are put in the same as the front risers, except that they are one size smaller, being $1^1/_4$-in. pipe. At a point near the ceiling of the first, second and third floors, $^3/_4$-in. lines for gas, vacuum and air, and 1-in. for water, are connected to risers; these lines are continued about 4 in. apart along near the hall partition to each end of the building, and are supported by $^3/_4$-in. pipe hangers, made square and fastened to the ceiling. There is one hanger in each 10-ft. room. Three-eighths in. lines for gas, vacuum and air, and $^1/_2$-in. for water, are connected to these lines and dropped straight down to each partition. These lines are continued down to the laboratory tables and along above them, leaving $^3/_8$-in. openings for gas, vacuum and air, and four $^1/_2$-in. openings on the water line, in each room. These openings are one above the other, 4 ft. from the hall partition and 4 ft. apart; where there is a sink on each side of the partition, connections are run through the wall by the use of crosses and pieces. The lines from risers at the rear of the building are put in the same as the front line, except that horizontal feed lines are one size smaller. The vacuum and compressed air lines were tested with 30 lbs. air pressure for 1 hr. after all connections had been put in and fastened.

LABORATORY SINKS—One hundred and one 14 × 20 in. sinks with patent overflow were set on $^3/_4$-in. galvanized pipe frames, having flanges on the floors, with braces half way up and binders on top, and made so that the tops of the sink set 3 ft. above the floor. As mentioned, each sink has a $1^1/_4$-in. extra strong lead waste pipe, fastened to the board under the laboratory table, with open ends to empty into receptors.

WASTE SINKS AND FOUNTAINS—Three 18 × 30 in. cast-iron enameled sinks, set on brackets, supplied with hot and cold water, are installed in the basement, two for drinking fountain waste and one for laboratory use: $1^1/_4$-in. galvanized waste lines, connected to 2-in. risers which empty into the sinks in the basement, were run from the fountains. These fountains are supplied through block-tin pipe having all joints soldered with pure tin. The water flows by gravity from the still near the center of the building in the attic which has been described. The main lines down are $^3/_4$-in. I. D. 12-oz. block-tin pipe with $^1/_2$-in. I. D. 8-oz. block-tin pipe branches to each fountain. This pipe was furnished and placed by the plumbing contractor, while the still was furnished and installed by the Institute. The drinking fountains, six in number, have self-closing compression bibbs.

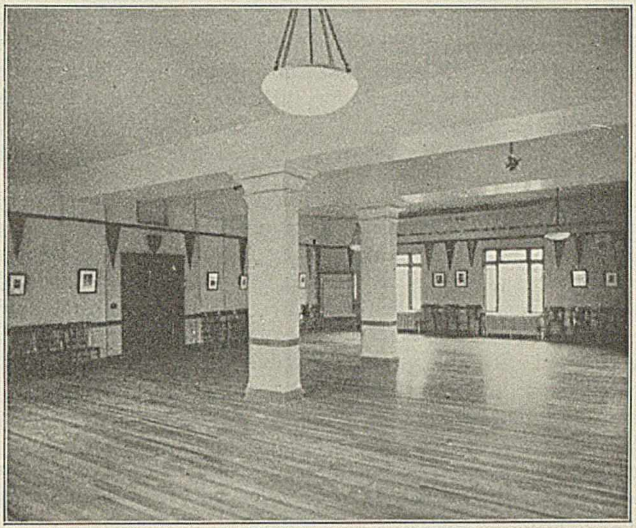


FIG. 13—A VIEW IN THE ASSEMBLY HALL

VENTILATING SYSTEM AND FAN—A No. 5 full housing multi-vane exhauster, provided with sub-base for motor, is installed on a concrete slab in the attic. The base for both the motor and fan is set on heavy $^1/_8$-in. sheet lead and 1-in. felt, bolted to the concrete slab. After mounting the wheel on the motor shaft, inside of the housing, it was coated with "Bitumastic" enamel. The exhauster is directly connected and is driven by a 3 H. P. motor, 690 R. P. M. The motor is for 110 volts A. C. 60 cycles, 3-phase.

The sewer pipe risers in the brick walls to the attic floor were built in by the brick contractor, while the plumbing contractor connected all risers with terra-cotta pipe run along the walls on the floor and covered these with concrete. The four risers connecting these lines to the fan are of extra heavy cast-iron, coated inside with "Bitumastic" enamel and supported from the ceiling on pipe hangers spaced 5 ft. apart. The exhaust line from the fan to the stack is connected with a No. 14 gauge galvanized iron pipe coated with "Bitumastic" enamel inside and out. All joints are made with a mixture of asphalt and kaolin.

VACUUM CLEANER RISER—Risers are provided for a vacuum cleaner; these are installed from the basement to 1 ft. above the fourth floor. This pipe is black iron with drainage fittings, and the risers are $2^1/_2$ in. with 2-in. openings on each floor, 1 ft. above the floor and 1 in. back from the finished wall in the hall. There is a total of 8 openings.

FIXTURES—The plumbing fixtures are connected with screw-pipe run exposed under the ceilings; all waste 2 in. and under are brass, and over 2 in., galvanized iron pipe with galvanized drainage fitting. The fourth floor has been roughed the same as were the second and third floors, the openings being left ready to connect the fixtures, which will not be put in at present.

It may be mentioned in passing that the slop sinks, 18 × 22 in., are provided with Mueller self-closing compression bibbs; that the washstands, 20 × 24 in., are equipped with Mueller self-closing china index compression basin cocks; and that there are three slop sinks, two showers, seven closets, three urinals and seven washstands throughout the building, and three sinks in the basement. A heavy lead pan is placed under all showers; there are two iron ladders for the receptors; and all valves have numbered brass tags.

ELECTRIC WIRING SYSTEM

CONDUITS—All wiring in the building is run in conduits of wrought iron pipe, enameled, galvanized or sherardized inside and outside, not smaller than $^5/_8$ in. inside diameter; and only one circuit is placed in each conduit. The conduits are fastened at least every 8 ft.; the joints are water-tight with standard couplings of the same material as the pipe, and the corners are turned with elbows on long radius bent on the pipe. No conduits are laid in contact with or near steam piping, and all are concealed. The conduits installed under the basement floor are of pipe known as extra heavy conduit; they have joints made with white lead and are gas- and water-tight. After installation, these conduits were tested with a gas pump and maintained a pressure of 2 in. of mercury with pumping.

OUTLET BOXES—At each outlet a galvanized pressed steel outlet box of not less than No. 12 gauge is placed and securely fastened; each box is provided with threaded insulated studs for supporting fixtures. All outlet boxes for the ceiling or bracket outlets are round and are small enough to be covered by a 4-in. fixture canopy. All switches other than the switches in the cut-outs are provided with square boxes.

The conduits are fastened to these boxes with lock-nuts and bushings, and there is sufficient room for the insulation of the joints, wires and bushings. It may be noted that all boxes are so set that all fixtures stand at right angles to the wall or hang plumb; they are designed so that the concrete, brick, etc., fit the same, in order to have the finished plate cover the joints between the box and the finished surfaces.

WIRES—No wire smaller than No. 12 B. & S. gauge is used and all wires larger than No. 10 B. & S. are stranded. The copper for the conductors is thoroughly tinned and possesses a conductivity of at least 98 per cent of that of pure copper. The wires for the A. C. flush plugs above the first floor and including the laboratories on the first floor, are No. 10 Duplex. The rubber insulation is protected by a braided covering which meets with all the requirements of the "National Electric Code" for high-grade wire.

Tests for insulation were made on a complete length without braiding, of not less than 500 ft., and after 48 hrs. immersion in water at 60° F. The tests were made with a well-insulated battery and galvanometer of not less than 150 volts, the readings being taken after electrification for one minute. It was required that each conductor stand a test of 2,000 volts for a period of five seconds after the insulation test, using the current from a generator and transformer.

All wires are of such sizes that with all the lights called for burning, and with the maximum output of power, there is no undue heating of the wires and cables, and the loss of potential between the service and any outlet is not greater than 4 volts. The drop in potential on any one circuit from the cut-out to the farthest lamp, with all lights on the circuit burning, is not greater than 1 volt. The main feeders are so proportioned that the drop in potential does not exceed 2 volts and the drop in the sub-feeders 1 volt.

The loss of potential is based on 16 candle-power 110 volts, 55 watt lamps. The building is wired for 16 candle-power incandescent lights, and not more than 660 watts or 12 lights have been allowed on any branch circuit.

MAIN FEED CONDUITS—Two 3-in. conduits for light and power, and one 3-in. conduit for telephone are provided from a manhole in front of the building to the transformer room in the basement. Two 3-in. conduits are also installed for light and power from a pole at the rear of the building. These conduits are carried to the main switchboard, with the exception of the telephone conduits, which terminate at the telephone junction boxes.

MAIN FEEDS FOR PANEL BOARDS—Conduits of proper size are installed from the main switchboard to each panel board on every floor. There are two separate lines of conduits to each panel board; one for A. C., the other for D. C. current.

SWITCH LIGHTING—Ten-ampere flush push switches of the "Hart-Diamond H" make are installed in suitable boxes on the face-plate to match the surrounding hardware. The backs of all plates come flush with the finished plaster line.

Where there are more than one switch at any one location, they are grouped under one gang plate.

FLUSH PLUG AND RECEPTACLE OUTLETS—Flush plug receptacles of the "Diamond H" make are installed in suitable boxes with face-plate to match the surrounding hardware, the plates being flush with the wall line. The plugs are 4 ft. above the finished floor line and are arranged for two different currents; the switch plates are accordingly engraved.

SYSTEM—The system for lighting and power is 110 to 220 three-wire A. C. current. For special service 110 two-wire D. C. current is provided.

POWER—There are installed an elevator motor, a ventilating motor, and a vacuum cleaner motor. The motor for ventilating[1] is, of course, installed in the attic.

CALL BELLS—Two 1-in. conduits are installed from a point near the Central Telephone Exchange on the first floor in the General Office to a wire shaft terminating in the telephone junction box on the first floor; it is continued up through the building and a 25-point terminal is furnished. From the telephone junction box a $^1/_2$-in. conduit is carried for the bell located in each room. The 3-in. bells are of the wood box type and "Fartay" manufacture.

SPECIAL OUTLETS—The outlets in the basement, on the floors of the electric furnace room and machine shop, consist of 8-in. square cast-iron boxes, drilled to receive the 2-in. conduit, and have brass water-tight covers set flush with the finished floors. The special outlet for the Assembly Hall is of the "Kleigle" make, of 60 amperes capacity.

HALL LIGHTING—The outlets at the stair landing are controlled by a special circuit from the first floor panel board; the other hall lights are controlled from panel boards located on each floor.

PANEL BOARDS—The panel boards for lighting are of the Pittsburgh Electric Machine Company's manufacture, with 3-wire bus-bars and 2-wire branches, and with 30-in. ampere circuit switches and main switch button. Each panel board is divided into two separate sections, one for lighting, namely, the 3-wire bus-bars, and one for the D. C. current, which has 2-wire bus-bars.

Each additional panel board is included in the flush, tight steel box provided with a door with a Yale lock. The boxes are 6 in. deep inside and have a 4-in. gutter around same. All panels have cartridge fuses and are constructed of 1-in. marble, with the necessary marble lining slotted for wires.

The main panel board consists of two separate panels, one for A. C. current and the other for D. C. current, and is mounted on an angle-iron frame; all necessary switches for the sub-feeders are mounted thereon.

The main switchboard is mounted on this panel board and

[1] See VENTILATING SYSTEM AND FAN, *supra*.

allowance is made for leaders; all connections are on the rear of the board, which is built of 2-in. white marble.

The mountings on the panel and main boards are completed with bus-bars mounted on the faces of the boards, with the exception of the main board, and the conducting parts are of highly polished and lacquered copper of ample size and design to prevent heating. Each branch circuit is plainly numbered and suitably lettered, and directory plates are placed, in convenient locations, to indicate the location of lines and power controlled by each switch or fuse.

The main bus-bars and brass and copper bars are in no case less than $^1/_8 \times {}^1/_2$ in. Only rolled or drawn copper was used in the construction of the mounting, copper castings not being permitted.

Switches or additional panel boards have a carrying capacity of at least 30 amperes, and the jaws of all switches are sweated into the bars.

The fuse connections throughout the building are the N. E. C. enclosed type, of which a full equipment has been furnished.

ORNAMENTAL IRON

The stairs are constructed with channel outside and plate wall strings, steel beams and angles, cast-iron treads, risers, platforms and base on sections. The hand railings are made from brass pipe and channels. The newels are made from cast iron and the balusters from steel; both received one coat of black paint before and one coat after erection.

The elevator shaft is enclosed with a simple design iron frame and iron doors with wire-glass panels. Both doors are arranged to swing out to permit the loading of large pieces of machinery, and the door openings in the basement hall are provided with channel iron frames.

MAIN ENTRANCE AND STAIRWAY

A special feature of the main entrance is the bronze doors, each 3 ft. 6 in. × 11 ft. 6 in., leading into a marble vestibule, 4 ft. × 7 ft. 6 in. × 12 ft. 8 in., with enriched cornice and ceiling. The vestibule, main hall (15 ft. 10 in. wide × 43 ft. long × 12 ft. 8 in. high) and stairways have pink Tennessee marble floor and base.

PLASTERING

All ceilings, walls and partitions in the basement, second and third floors, including the elevator shaft, were plastered with mortar composed of one part cement and two and one-half parts sand, which was skimmed with one part cement and two parts Ligonier sifted dust; this has made a hard surface.

The entire first floor, basement hall ceiling, stair halls and corridors were plastered with a patent plaster, which was skimmed with lime and plaster of Paris. The basement hall walls and the ceiling of the front pavilion were finished in cement in imitation of stone blocks. The ornament in the basement hall is of stucco.

FLOORING

CEMENT FLOORS—Cement floors were constructed in the basement and at the front and rear entrances as follows: All places where the original grade had been disturbed were soaked and rammed; the surface was leveled off, rammed, and then a 4-in. bed of clean cinders was placed thereon. After soaking and ramming, a 4-in. bed of $1:2^1/_2:5$ concrete was placed on the cinders. The floors were finished with a 1-in. top coat composed of one part cement and two parts crushed Ligonier limestone, screened through $^1/_4$-in. mesh screen. After troweling the top coat, it was kept covered with a 1-in. layer of sand kept wet for six days; the top coat and base were placed on the same day. The concrete floor was cut into blocks 4 ft. square, the cuts extending entirely through the base and top coat. The floors have a uniform fall to the bell traps.

FIREPROOF FLOORS—The first, second, third, fourth, and attic floors are constructed of hollow fireproof blocks, with reinforced concrete ribs and 2 in. of concrete on the top. The floor slabs were composed of 1:2:4 concrete. The tops of the floors were leveled for the reception of the $^1/_2$-in. top coat of composition floor material.

COMPOSITION FLOORS—The first, second, and third floors, except the Assembly Hall floor, are covered with a top coat of composition floor with 4-in. sanitary cove base of the same material, put down in continuous sections in each room and hall. This material, which was laid by the Marbleloid Company, of New York, under the direction of Dr. R. R. Shively, a Fellow of the Institute, who has worked two years on such compositions, is gratifyingly satisfactory; it is straight, free from all imperfections, possesses resiliency, and is sanitary.

The floors were laid in two layers. The under or fibrous layer, which took care of the inequalities in the cement, is about $^5/_{16}$ in. thick. The upper layer is $^1/_2$ in. thick; it is of such composition that the absorption of water did not exceed 9 per cent when test-pieces were immersed for 24 hrs.

The composition floors are practically acid-proof, and are guaranteed not to crack, bulge, change color, nor to show a coating of white material on the surface after standing. When the floors were laid close to steam or hot water pipes, the latter were covered with asbestos $^1/_4$ in. thick. After troweling to a smooth surface, the floors received two coats of linseed oil.

LECTURE ROOM FLOOR—In the Assembly Hall, or Lecture Room, 2 × 4 in. beveled chestnut sleepers, 16 in. on centers, were bedded in cinder concrete, covered with one layer of asphalt-coated paper, and then $^7/_8 \times 2$ in. tongued and grooved maple flooring was put down.

INTERIOR FINISH

All interior finish was worked from clear oak. The entire first floor finish is quarter-sawed white oak; all other parts of the building are finished in plain-sawed red oak.

PAINTING

All exterior woodwork, except the outside doors and frames, received one coat of linseed oil stain and three coats of linseed oil paint. The first floor rooms received one coat of acid stain and two coats of wax; the tops and bottoms of doors and sash were primed and painted with two coats of linseed oil paint. The stair balustrade, newels and other exposed iron work had two coats of linseed oil paint, and the elevator doors and frames were finished with three coats of black paint and left with a dull finish.

The interior finish in all halls and corridors received one coat of acid stain and two coats of interior varnish. The remainder of the building received one coat of linseed oil stain and two coats of linseed oil paint.

All metal ware likely to be exposed to acid fumes in the laboratories has been treated with an acid-proof paint.

GLAZING

All exterior windows are glazed with selected polished plate-glass; toilet room windows are glazed with double-chipped polished plate-glass, and polished plate wire-glass is used in all hoods and in the elevator doors and frames.

ILLUMINATING GLASS

The illuminating glass used throughout the building is that manufactured by the Phoenix Glass Company, of Pittsburgh, Pa. This glass has been developed along scientific lines and represents the last word in efficiency; it has very low absorption. The semi-direct system is installed.

"Magnolia" glass bowls are installed in the executive suite, library, Assembly Hall, and corridors; these bowls are of artistic design, the particular feature thereof being the distinctive line etchings characteristic of the Phoenix products. In the general office, the "Phenixlite" is used; this is a simple light of very high efficiency.

HEATING SYSTEM

The heating system consists of a gravity-return hot water heating apparatus, erected and so arranged as to insure a free and easy circulation of water throughout the entire system, and so constructed that any of the radiators may be shut off without interfering with the circulation of the rest of the system.

STOKER—There is installed one "Detroit" stoker for a 54 in. x 14 ft. horizontal tubular boiler, including stoker fronts, coal magazines, grates, clinker crushers, firing tools, special fire-brick for stoker arch and fire door opening, engines, and operating mechanism. The stoker is of the reciprocating type, with extension setting, and is furnished with one variable speed A. C. motor with starting boxes attached to the side.

STEEL TUBULAR BOILER—The boiler is 54 in. in diameter, 14 ft. long out to heads; it is of the flush end type, constructed of open-hearth steel of standard quality, $^{13}/_{32}$ in. in thickness, having heads $^1/_2$ in. thick. It contains fifty lap-welded charcoal tubes, 4 in. in diameter, 14 ft. long, set in vertical and horizontal rows, not less than 1 in. apart each way, except in the middle two rows, which are 2 in. apart vertically. No tube is nearer than 3 in. from the shell. All riveting, lapping, and spacing were done in accordance with the most approved practice of recognized steam boiler inspection. The boiler was designed for a working pressure of 150 lbs. per sq. in.; it was tested under hydrostatic pressure.

A cast-iron top half-front was built in; this was supplied with double flue doors.

CAST-IRON BOILERS—Two horizontal hot water boilers of the "Presto" type, having a rated capacity not less than 6,425 sq. ft. each, are installed. The boilers are covered with 85 per cent magnesia blocks, $1^1/_2$ in. thick, a 1-in. air space being left between the boiler and the covering; this is covered with a $^1/_2$-in. coat of cement, skimmed with a $^1/_4$-in. coat of cement, and finally covered with canvas sewed on and painted. For the relief of the boilers of any excess pressure, a "Crosby" water relief valve is placed on each. Each boiler is furnished with one brass case water-works gauge, $8^1/_2$-in. dial. A brass case hot water thermometer, of the Hohman & Mauer Company's make, is placed on the flow pipes where they leave the boiler.

An approved gas burner with controlling device is installed complete under each cast-iron boiler.

FIXTURES—The above equipment includes all the necessary boiler castings and iron work, a complete set of hot water fixtures, including automatic fire regulator, thermometers, altitude gauge, etc., for each boiler. There is also installed one complete return tubular "Bayer" steam soot blower, connected with a $^1/_2$-in. air line near the boiler.

SMOKE CONNECTIONS—The smoke outlets on the boilers are connected to the openings in the smoke flues with black iron smoke connections, No. 16 gauge for the cast-iron boilers and No. 10 gauge for the tubular boiler, these connections being equipped with a full-sized balance damper with locking devices.

EXPANSION TANK—A steel open-expansion tank with cover is erected in the attic. This tank is made of $^1/_4$-in. plate with angle-iron frame around the top; it has a capacity of 250 gals., is provided with all necessary gauges, fixtures, and a float valve, and is connected to the system by means of expansion and circulating pipes. It is equipped with a 2-in. overflow which spills out on the basement floor. The tank is placed on supports 2 ft. above a 26-in. radiator.

PIPE—The main supply and return lines are supported from the first floor on heavy wrought-iron pipe hangers, spaced every 10 ft. All piping 7 in. and larger has standard flanges and fittings; all other pipe work was made direct into fittings with screwed threads. All flange joints were made with "Rainbow" packing. All pipe is standard merchant black pipe.

VERTICAL RISERS—The riser pipes leading to the first, second, third and fourth floor radiators are concealed in the outside walls; they are extended 1 ft. above the fourth floor and looped. All risers are valved with "Nelson" gate valves and have $^3/_4$-in. gate valves at the back for drains. All branch connections between the risers and the radiators are run on the ceiling below. Pipes passing through the walls and floors are provided with surrounding escutcheons.

RADIATION—One hundred and one radiators, of the Beaver and Invincible models, manufactured by the Pressed Metal Radiator Company, are installed throughout the basement, first, second and third floors. These radiators contain a total of $5,681^1/_2$ sq. ft. of heating surface.

All radiators in the basement are of the Beaver type, 32 in. high, and hung from the ceiling, except in one room, where the radiator is hung on the wall. All radiators above this floor are of the Invincible type, 26 in. in height, with 6-in. legs.

Generally speaking, the small research laboratories on the second and third floors contain one radiator; the large laboratories are provided with two. These were installed in accordance with a carefully prepared schedule of radiation.

NON-CONDUCTING COVERING—All flow and return mains and their branches, also all rising lines and horizontal radiator connections throughout the building, are covered with the best quality moulded sectional covering of 85 per cent magnesia, 1 in. thick, and then covered with 8-oz. white canvas duck, secured in place with lacquered bands. All fittings throughout the building are covered in the same manner. All covering which is exposed received an additional covering of 8-oz. canvas, sewed on.

PAINTING—The radiators throughout the building are painted with aluminum paint.[1] All exposed piping in the basement and the iron work around the boiler are painted with one coat of the best black japan.

VALVES—A Lavinge packless lock-shield union-angle valve is installed on the return end of each radiator. A return valve is also installed on each riser loop on the fourth floor.

Each radiator, the top of each riser loop, and all points where a reduction of two pipe sizes occurs, are equipped with a nickel-plated lock compression air valve and key.

THERMOSTATIC CONTROL—All radiators are controlled by the American Radiator Company's thermostatic control system. All rooms in which the radiation is placed may be heated to a temperature of 70° F. when the outside temperature is at zero, with the water in the boiler at 180° F.

LIVE STEAM FOR LABORATORIES—A live steam system is installed in the basement with $^3/_8$-in. opening under each vent hood. This system is constructed of black pipe with cast-iron fittings and has a 10-lb. pressure. All upright and horizontal feed lines are covered with 1-in. thick asbestos covering and sewed canvas jacket. The canvas covering and all exposed pipes received two coats of asphalt paint. All $^3/_8$-in. branches are galvanized pipe. The horizontal feed lines have a 1-in. fall to 20 ft. towards the return lines.

The boiler for this system is placed in the boiler room. All connections from the feed lines are taken from the top and returned down to the vent hood; the horizontal lines have two pipe hangers in each 20-ft. room and one in each 10-ft. room.

ADMINISTRATION

The suite of the Director, Dr. Raymond F. Bacon, is on the first, the main, floor, with the general office and that of the editorial department adjacent. The executive suite contains the Director's private office, a room 20 x 24 ft.; Director's retiring room, 11 x 15 ft.; and Director's private laboratory, a room 20 ft. x 20 ft. 6 in., equipped the same as the large size research laboratories on the second and third floors.

The general office occupies a room, 24 ft. 6 in. x 38 ft. 6 in., in conjunction with a telephone central and in-

[1] This paint was kindly donated by Mr. Maximilian Toch.

formation bureau counter off the main hall; it is provided with a fireproof vault, 2 ft. 6 in. x 9 ft., a book closet, 4 x 8 ft., and a cloak closet. The secretarial force, which at present numbers five, is in charge of the Secretary to the Director. The walls of the general office are decorated with pennants of the various institutions of learning represented on the staff; it is customary for each Fellow to present a pennant of his alma mater as a pledge of his honor and fidelity to the Institute.

Two of the Assistant Directors, Drs. E. Ward

Fig. 14—The Private Office of the Director, Dr. Raymond F. Bacon

Tillotson, Jr., and Samuel R. Scholes, whose office adjoins the Assembly Hall on the first floor, are in direct charge of the individual researches in progress, with the exception of certain of the multiple fellowships, which are under Director Bacon's immediate supervision; they also exercise superintendence over the maintenance of supplies and equipment.

In addition to this administration of the internal affairs of the Institute, another Assistant Director, John J. O'Connor, Jr., attends to the presentation of the work of the Institute to prospective donors of industrial fellowships.

THE OBJECT AND WORK OF THE MELLON INSTITUTE[1]

By Raymond F. Bacon

The dedication of a permanent home for the Mellon Institute of Industrial Research and School of Specific Industries of the University of Pittsburgh marks an important point in the history of American industry and education. Wherever raw materials are secured or wherever they are made into goods to supply the many wants of man, there is a variety of problems awaiting solution. These may have to do with difficulties in manufacture, with the utilization of wastes, with the improving and cheapening of manufactured products, with finding new uses for products, or with the discovery of new and useful products. To aid industrialists in solving these problems, by bringing the wealth of contemporary science to bear upon them, the Mellon Institute was founded.[1] This Institute represents an alliance between industry and learning, the possibilities of which may be said to be without limit.

The alliance takes the form of what is known as "The Industrial Fellowship System." According to this system, an individual or a company having a problem requiring solution may become the donor of a fellowship by contributing to the Institute a definite sum of money, for a period of not less than one year. This money is used to pay the salary of the man or men selected to carry out the investigation desired, and the Institute furnishes such facilities as are necessary for the conduct of the work. The results obtained belong exclusively to the donor of the fellowship.

HISTORY OF THE INDUSTRIAL FELLOWSHIP SYSTEM

The idea of this system of practical coöperation between science and industry was formulated by Robert Kennedy Duncan, the late Director of the Mellon Institute, in 1906, while attending the Sixth International Congress of Applied Chemistry in Rome.

For some years previous to this Congress, Dr. Duncan had been in Europe gathering material for two of his books, "The New Knowledge" and "The Chemistry of Commerce." Through visits of inspection to the factories, laboratories and universities of some of the countries of Europe, and through conversations with industrialists and scientists, he had become impressed with the spirit of coöperation which existed between industry and learning which made for the advancement of both. At the same time, he became aware, more than ever before, of the fact that much of American industry, from the standpoint of manufacturing efficiency, was in a lamentable condition. The absence of the application of modern science was one reason for this condition.[2]

To remedy this, it occurred to Dr. Duncan to propose an Industrial Fellowship System. Upon his return from Europe to accept the chair of industrial chemistry in the University of Kansas, he established there the first Industrial Fellowship in January, 1907. The scheme was presented to the public by Dr. Duncan in an article entitled "Temporary Industrial Fellowships" in the *North American Review* for May, 1909, and a little later in the last chapter of his book on "The Chemistry of Commerce."

In 1911, Dr. Duncan was called to the University of Pittsburgh to inaugurate the system in the Department of Industrial Research, and the working of the fellowships began in a temporary building erected at a cost of about $10,000. In March, 1913,[3] Messrs. Andrew William Mellon and Richard Beatty Mellon, citizens of Pittsburgh and sons of the late Judge Thomas Mellon of the class of 1837 at the University of Pittsburgh, impressed by the practical value of the system, both to industry and to learning, es-

[1] Address delivered in abstract at the annual Alumni Banquet of the University of Pittsburgh, Hotel Schenley, February 26, 1915.

[1] "On the Value of Research to Industry," see Bacon, *Science, N. S.* **40** (1914), 871–81.

[2] See especially Duncan, This Journal, **3** (1911), 177, wherein the relation between chemistry and manufacture is discussed fully; and Duncan, *Harper's Mag.*, **126** (1913), 385–90.

[3] "On the Status of the Industrial Fellowship System Prior to 1913," see Duncan, *J. Frank. Inst.*, January, **1913**, 43–57.

tablished it on a permanent basis through the gift of over half a million dollars. While the Institute is an integral part of the University of Pittsburgh and works in close sympathetic accord with it, it possesses an endowment of its own and is under its own management. The present annual expenditure for salaries and maintenance is over $150,000.

On February 18, 1914, the Institute lost by death its founder and Director, Dr. Robert Kennedy Duncan. Dr. Duncan was succeeded by the writer, who had been Associate Director.

THE FELLOWSHIP AGREEMENT

The fellowships of the Institute consist of two kinds, individual and multiple. An individual fellowship utilizes the services of one man, directly responsible to the administration; a multiple fellowship, the intensive services of several men under the direction of a Senior Fellow who, in turn, is directly responsible to and under the administration.

Each fellowship that comes to the Institute is the subject of a definite agreement between the individual or company concerned and the Institute. While the agreement is modified from time to time, depending upon exceptional circumstances, the following is the form of single fellowship agreement now being used by the Institute:

........COMPANY'S FELLOWSHIP AGREEMENT

THIS AGREEMENT, made and entered into this....day of ...., 19.., between the Mellon Institute of the University of Pittsburgh, of the City of Pittsburgh, Pennsylvania, hereinafter called the "Institute," and the.................., of.. hereinafter called the "Company,"

WITNESSETH: That for the purpose of promoting the increase of useful knowledge, the parties hereto agree as follows:

1—The Company shall pay to the Institute annually in advance for a period of........years, beginning.............., 191.., the sum of.............dollars ($....) for the foundation of an Industrial Fellowship to be known as.............
....
FELLOWSHIP, the exclusive purpose of which is............
....
....

2—The Institute shall accept the sums so to be furnished by the Company and shall devote them to the furtherance of the problem of this Fellowship; and to this end all money received from the Company under this Agreement shall be paid over by the Institute in monthly installments to the holder of this Fellowship, in such amount as may be agreed upon by the Institute and the Fellow concerned, and expended for such apparatus and supplies related to this research as the Director of the Institute may deem it advisable to purchase and for travelling expenses related to the elucidation of the problem concerned. The Fellow shall be provided, at the expense of the Institute, with a separate laboratory and with such apparatus, supplies and reagents as in the opinion of the Director constitute a reasonable provision. The Company, on its part, shall coöperate with the Institute in this research by providing the Director thereof and the Fellow of this Fellowship with its sympathy and whatever knowledge of the subjects of research it may possess, and, on approval of the Company, with its factory facilities for large-scale experimentation.

3—The holder of the Fellowship provided hereunder shall be appointed by the Committee of Management of the Institute upon the nomination of the Director in accordance with the terms of his formal letter of application to and as approved by the Director, and he shall give his whole time and attention to the object of the Fellowship, with the exception, if the Director so elect, of three hours a week which he shall give to instructional work in the University of Pittsburgh. The Fellow shall work under the advice and direction of the Director and shall from time to time through the Director forward to the Company reports of the progress of his work. During the existence of the Fellowship provided hereunder the Company shall have the right, through and with the acquiescence of the Director, to employ and take into its regular service the Fellow of this Fellowship, upon terms to be agreed upon between the Fellow and the Company.

4—The Institute, at the expiration of the Fellowship, shall return to the Company any money paid to it by the Company, in case any thereof shall remain unexpended for the purpose of this Fellowship.

5—Any and all discoveries made by the Fellow during the term of this Fellowship, as well as all information obtained by him germane to the subjects of his investigation, shall become the property of the Company, subject to the terms and provisions of this Agreement, and the Fellow making such discovery or obtaining such information shall promptly and without demand make revelations of all such information and discoveries. Such revelations shall be made to the duly designated representatives of the Company directly, or through the Director, as the Director may determine.

6—The Fellow of this Fellowship making a discovery or invention germane to the subjects of his investigation shall, at any time, at the option and expense of the Company, apply for letters patent, and shall upon demand assign such letters patent and any and all rights to such invention to the Company under the conditions of this Agreement. In case the Company desires to keep secret such discovery or invention, or for any reason desires that letters patent shall not be applied for, the Fellow shall not at any time apply for patent or patents in his own name, and shall not disclose such discovery or invention to others except as herein provided.

7—The Company shall, in addition to the sum paid to the Institute as foundation for the Fellowship, pay to the Fellow a maximum cash bonus of..........dollars ($......) or any part thereof which in the opinion of the Board of Arbitration (hereinafter provided for) is deserved by the Fellow of this Fellowship, and the amount of this payment and the time or times of payment shall be decided by the Board of Arbitration upon application of either of the parties hereto.

8—In the event of any difference of opinion between the parties hereto as to the interpretation of this Agreement, or the rights of the respective parties to this Agreement, the matters in issue shall be referred to a Board of Arbitration, which Board shall consist of a representative of the Institute and a representative of the Company, and a third person whom these two shall select. The decision of this Board shall be obtained without recourse to the courts and, when rendered, shall be binding upon the parties hereto.

9—During the term of this Fellowship, the holder thereof may publish such results of his investigation as do not, in the opinion of the Company, injure its interests. On or before ...., 19...., the holder shall have completed a comprehensive monograph on the subjects of his research. The subject matter of such monograph shall not contain specific information of the process or methods of the Company, but it shall be confined to a statement of new discoveries of scientific fact obtained by this Fellowship, and such statement shall not contain data or information in regard to the cost of manufacture by any process revealed in such statement. A copy of this monograph shall be forwarded to the Company and a copy shall be signed and placed in the archives of the Institute until the expiration of three years from the time hereinafter provided for the termination of this Fellowship, when the Institute shall be at liberty to publish it for the use and benefit of the public.

In the event that in the opinion of the Company such publication at such time will unduly injure its interests, it shall have the privilege of appealing at any time for an extension of time of such publication to the Board of Arbitration provided for herein, which after considering the appeal shall, if in its opinion such publication will unduly injure the Company's interests, extend the time of publication to a time when in the Board's opinion publication will not unduly injure the interests of the Company.

10—The Fellowship provided under this Agreement shall terminate..........day of.............., 19.....

IN WITNESS WHEREOF, the parties hereto have caused their names to be subscribed the day and year above mentioned by their duly authorized officers.

	MELLON INSTITUTE OF
Witness:	UNIVERSITY OF PITTSBURGH,
....	By..........................
....	....
	By..........................

It is evident from this agreement that four different parties are affected: the Company; the Fellows; the University; the Public.

1—THE COMPANY

The Company obtains from the Institute such research laboratory facilities as but few industrial concerns possess. Even more important, it obtains complete library facilities, which are so valuable in research work.

There is a scarcity of men gifted with the genius for research, and it requires much experience in selecting suitable men and in training them to the desirable degree of efficiency, after having determined the special qualities required. Important qualifications in industrial researchers are keenness, creative power, and confidence; these are often unconsidered by manufacturers, who, in endeavoring to select a research chemist, are likely to regard every chemist as a qualified scientific scout. The men who are best trained for a particular problem are carefully chosen by the Institute and these work under the supervision of a staff experienced in handling industrial research problems. The Company thus secures at a comparatively small cost ideal conditions for working out industrial problems which would cost any single company probably from $60,000 to $70,000 each year to duplicate in a laboratory which it might establish in connection with its own factory.

The Institute, through its affiliation with the University, is able to offer the Company large and important consultative facilities—psychological, physical, engineering, biological, etc.

The Company has an opportunity to obtain for its own organization young men who have had not only thorough scientific training but very special training in the Company's own lines as acquired through its Fellowship.

There is about university work, as differentiated from the factory, freedom from interference, correct judgments concerning progress, and an atmosphere sympathetic to research.

All these advantages, laboratory, library, consultative and inspirational, together with the supervision and administration of these Fellowships, the Institute offers gratuitously to any company having important problems offering a reasonable chance of solution, and it undertakes, as well, to surround these researches with the necessary secrecy.

Experience has proved that through this system of Industrial Fellowships a company can generally do its research work more efficiently and cheaply in the Institute than in its own laboratory. Finally, it has been found that where there exists a close and sympathetic coöperation on the part of the Company, many remarkable results have been achieved.

2—THE FELLOWS

The agreement gives to ambitious young men an opportunity to work out, in a scientific manner, great industrial problems, and not only to work them out in the laboratory but, if the laboratory solution appears to have commercial possibilities, to go further and to try out the methods evolved on a factory scale and, ultimately, to put new processes into industrial operation.

It gives young men a chance to obtain much experience in practical research while they are receiving a satisfactory remuneration. Each Fellow has the benefit of the Institute's very excellent apparatus, chemical and library equipment—facilities which are so essential in modern research; and because of these opportunities and that of being able to pursue postgraduate work for a higher degree, it has been demonstrated that a higher type of research chemist can be obtained by the Institute for a certain remuneration than can be generally secured by manufacturers.

Finally, if the Fellows succeed in a practical way, they receive, through their bonus, a substantial, practical reward, and often the opportunity to become permanently connected with the Company concerned in the agreement.

3—THE UNIVERSITY

The University, under the agreement, fulfils its function in increasing the sum of knowledge; the fact that it is useful knowledge does not make it any less valuable. Furthermore, the right, after a reasonable time, to publish such knowledge is assured to the University. The University also obtains a highly trained staff of specialists as a faculty for a School of Chemistry and Chemical Engineering. Then, too, the University undoubtedly feels the stimulating influence of having in its midst a large body of trained investigators engaged in research work.

4—THE PUBLIC

The public is also advantaged through this system. No discovery can go to the public as a useful actuality of achievement except through some company, and every useful and significant fact developed by a company is a permanent asset to the human race.

The agreement provides for the publication of the results of a Fellowship for the benefit of the public at the expiration of three years from the time of termination of the agreement, provided that publication at that time does not unduly injure the interest of the donating company. However, many of the by-paths which appear in every investigation yield results of scientific interest and a number of papers detailing results of work of this character have been published by the Institute from time to time.[1]

INDUSTRIAL RESEARCHES IN PROGRESS

A list of the twenty-three Fellowships in operation at the time of the dedication of the new building (February 26, 1915), together with the men appointed for them, follows.

9—CRUDE PETROLEUM

September 22, 1911—$10,000, 1st year; $10,000, 2nd year; $10,000, 3rd year; $10,000, 4th year, including apparatus fund.

BONUS: Collective interest, 10 per cent.

FELLOWS: Benjamin T. Brooks, Ph.D., University of Göttingen, SENIOR FELLOW. Clinton W. Clark, A.M., Ohio State University—*Work completed.* Lester A. Pratt, M.S., New Hampshire College—*Work completed.* Hugh Clark, A.M., Ohio State University—*Work completed.* Arthur H. Myer, A.M., Leland Stanford, Jr., University—*Work completed.* Frederick Padgett, M.S., University of Pittsburgh. F. W. Bushong, Sc.D., Emporia College—*Work completed.* I. W. Humphrey, M.S., University of Kansas. George W. Stratton, Ph.D., Ohio State University—*Work completed.* Harold Hibbert, D.Sc., Victoria University. Harry Essex, Ph.D., University of Göttingen.

18—BAKING

May 12, 1913—$6,000 a year for two years, and $500 apparatus fund.

BONUS: $10,000.

FELLOWS: Henry A. Kohman, Ph.D., University of Kansas, SENIOR FELLOW. Charles Hoffman, Ph.D., Yale University—*Work completed.* Truman M. Godfrey, B.S., University of Kansas. Lauren H. Ashe, B.S., University of Pittsburgh.

19—ALUMINUM

May 12, 1913—$5,000 a year for two years, including apparatus fund.

BONUS: $10,000.

FELLOWS: Hugh Clark, Ph.D., University of Pittsburgh. Lester A. Pratt, Ph.D., University of Pittsburgh. Frank D. Shumaker, B.S., University of Pittsburgh.

20—GLUE

May 12, 1913—$1,500 a year for two years and $300 apparatus fund.

FELLOW: Ralph C. Shuey, B.S., University of Kansas.

21—SOAP

May 12, 1913—$1,500 a year for two years and $300 apparatus fund.

FELLOW: Ben H. Nicolet, Ph.D., Yale University.

22—GLASS

July 14, 1913—$1,500 a year for two years and $300 apparatus fund.

BONUS: $3,500.

FELLOW: R. R. Shively, Ph.D., University of Pittsburgh.

23—RELATION OF ELECTRICAL POTENTIAL TO CATALYTIC ACTION

July 14, 1913—$1,500 a year for two years and $300 apparatus fund.

BONUS: 5 per cent industrial results.

FELLOW: Frank F. Rupert, Ph.D., Massachusetts Institute of Technology.

25—YEAST

July 14, 1913—$5,200 a year for two years, including apparatus fund.

BONUS: $10,000.

FELLOWS: F. Alexander McDermott, M.S., University of Pittsburgh, SENIOR FELLOW. Ruth Glasgow, M.S., University of Illinois. William Smith, B.S., Scholar, University of Pittsburgh. James C. Cuthbert, Scholar, University of Pittsburgh—*Work completed.* Lauren Hewitt Ashe, B.S., Scholar, University of Pittsburgh—*Work completed.*

27—LEATHER

October 22, 1913—$1,000, 1st year, and $200 apparatus fund; $1,650, 2nd year, including apparatus fund.

BONUS: 10 per cent interest.

FELLOW: R. Phillips Rose, M.S., University of Kansas.

28—FERTILIZER

November 1, 1913—$2,500 a year for two years, including apparatus fund.

BONUS: $5,000.

FELLOW: Earl S. Bishop, Sc.D., Queen's University, Ontario.

[1] A list of these contributions, 1912–1914, is given in *J. Frank. Inst.*, November, **1914**, pp. 629–32.

30—RADIATORS

November 18, 1913—$2,000 a year for two years, including apparatus fund.

FELLOW: J. C. Ballantyne, B.Sc., University College, London; M.S., University of Pittsburgh.

31—TURBINE ENGINES

September 1, 1914—$1,800 a year for one year, including apparatus fund.

BONUS: $3,000.

FELLOW: Rudolph McDermet, M.S. in E.E., University of Illinois.

34—FATTY OILS

July 1, 1914—$2,100 a year for one year, including apparatus fund.

FELLOW: Leonard M. Liddle, Ph.D., Yale University.

35—ORES

June 15, 1914—$5,300 a year for one year, including apparatus fund.

FELLOWS: Charles O. Brown, A.M., Cornell University. James B. Garner, Ph.D., University of Chicago. Clement L. Perkins, B.S., New Hampshire College. E. R. Weidlein, A.M., University of Kansas, SENIOR FELLOW (*advisory*). G. A. Bragg, B.S., University of Kansas (*advisory*). H. D. Clayton, B.A., Ohio State University (*advisory*).

36—FLOTATION

June 15, 1914—$3,200 a year for one year, including apparatus fund.

FELLOWS: Harry P. Corliss, Ph.D., University of Pittsburgh. Clarence L. Weirich, M.S., University of Pittsburgh.

37—ACETYLENE

November 15, 1914—$3,000 a year for one year, including apparatus fund.

BONUS: $5,000, maximum.

FELLOW: George O. Curme, Jr., Ph.D., University of Chicago.

38—DENTAL SUPPLY TRADE PROBLEMS

July 1, 1914—$3,200 a year for one year, including apparatus fund.

FELLOWS: Clarence C. Vogt, Ph.D., Ohio State University. H Edmund Friesell, D.D.S., Pennsylvania Dental College (*advisory*).

39—FAT COMPOUNDS

October 1, 1914—$2,500 a year for one year, including apparatus fund.

FELLOW: Edmund O. Rhodes, M.S., University of Kansas.

40—STONE

October 26, 1914—$1,800 a year for one year, including apparatus fund.

FELLOW: H. C. Holden, M.S., New Hampshire College.

41—COPPER

November 1, 1914—$6,000 a year for one year, including apparatus fund.

FELLOWS: E. R. Weidlein, A.M., University of Kansas, SENIOR FELLOW. H. D. Clayton, B.A., Ohio State University. G. A. Bragg, B.S., University of Kansas.

42—GLASS

December 3, 1914—$1,800 a year for one year, including apparatus fund.

FELLOW: John F. W. Schulze, Ph.D., Clark University.

43—LAUNDERING

February 1, 1915—$1,800 a year for one year, including apparatus fund.

FELLOW: Harvey G. Elledge, B.S., University of Kansas.

44—LAND DEVELOPMENT

February 1, 1915—$1,000 a year for one year.

FELLOW: Will E. Vawter, B.S., University of Kansas.

THE SCHOOL OF SPECIFIC INDUSTRIES

The new building of the Mellon Institute was especially designed to afford ample accommodation for a Graduate School of Specific Industries; and, as this is altogether a new idea in education, an explanation of its purpose is in order.

As the Industrial Fellowships which constitute the basis of the system in operation, are constantly increasing in amounts subscribed by the industrialists for their maintenance, and, as well, in their importance, it is, of course, obvious that the seventy researchers thus provided for will number among them men of national or international importance, to say nothing of the fact that, as a class, they are carefully chosen as picked men from the best institutions of learning and from the greatest industrial organizations in this country. Such a corps of workers will, therefore, be of the highest potential value as an educational staff for students fitted to receive such instruction. Enthusiastic young chemists who have received a thorough training in the fundamentals of the science and who desire to make their life-work in a certain industry, may thus become thoroughly familiar with the application of chemistry to that particular industry—by being in intimate contact with those who are devoting their whole time to the problems of that specific industry. Thus, for example, the man who wishes to become an expert in *glass* will work in the laboratory and in the glass factory with those who have, for a long time, been devoting themselves to the problems of the glass industry and who are in the forefront of that industry.

The young man just out of school, going directly into the factory, is apt to encounter many conditions so discouraging that, unless he is of very exceptional calibre and receives more than ordinary encouragement from those in charge of the business, he may lose his enthusiasm and degenerate into a routine man, and, perhaps, never be able to contribute anything to the upbuilding of that particular industry. American factories, as a rule, do not have adequate laboratory facilities for research, and too many American business executives do not appreciate the time and difficulties involved in prosecuting successful research. Many lines of business are so full of tradition and prejudice that serious obstacles are often deliberately put in the way of the young chemist by misguided workmen and superintendents to prevent his experiments from turning out successfully. Another point of considerable importance in this matter has to do with the organization of many American factories. While the higher executives of the company may thoroughly appreciate difficulties of research and the time often necessary for its successful prosecution, in the actual factory organization the chemist is very often placed immediately under and must report to some man who does not have such breadth of view. This man is often the factory superintendent, who may be chosen primarily because of his ability as a driver of men. The factory superintendent may tell the chemist to undertake a certain piece of research. In a few weeks —or sometimes even in a few days—he comes around to find out the result obtained. If no result is available, very often the chemist is shifted to other problems; or it may be that something unusual, which has just arisen, seems of pressing importance and the chemist is asked to drop everything else to take up the new matter. The net result is that after a few attempts by the young chemist to do big things, unsuccessful because the necessary uninterrupted time was not allowed, the factory superintendent reaches a conclusion that nothing can be gained by the research of the chemist, and the chemist himself, especially if young and inexperienced, may lose his ideals of research.

Under the system of Industrial Fellowships in operation at the Mellon Institute, both the Institute and the Fellow have the sympathy and hearty coöperation of the higher officials of the corporation concerned; and yet in his work the Fellow is, to a considerable extent, independent of that corporation, as he is under the immediate control of the administration of the Institute. The Institute is thus able in many cases to push through to a successful conclusion large-scale experiments in the factories of the corporation which could hardly be accomplished by the company's own chemists. The young student entering the School of Specific Industries learns the difficulties which must be overcome in successful large-scale work, not only on the purely scientific and experimental side but also on the human side, and finds that by proper and tactful methods these human difficulties can be met; so that, instead of losing his first rush of enthusiasm, he gains by actually seeing ideas and theories grow into commercial realities. Lectures are given on the problems of chemical industry, the methods employed in their attack, and on the design, erection and equipment of chemical plants; and specific problems of industrial importance are assigned to the student, who follows the steps preparatory to the solution thereof, from the laboratory to the unit plant stage. The Institute is especially well equipped for such instruction.

Mention may be appropriately made here of the Institute's "large-scale equipment." When a process, developed during the course of a fellowship, demands apparatus of a new type, which is not available in the factory, a unit plant is built. This plant is of such a size and is built in such a way that, when it is running smoothly, the manufacturer will feel justified in taking over its plan and spending such money as will be necessary to put in a very much larger unit or, it may be, several units. I might say that the companies which are using the Institute have, during the past year, spent approximately $55,000 in building small unit plants to develop the processes which have been worked out in the laboratory. This does not include many processes which were adapted to the factory equipment already on hand. In no case was any of this money for plants provided for in the original foundation of the Fellowship, but in every case, after conference, the company felt that the progress of the work and the results obtained appeared promising enough to justify them in the expenditure of this money for further development. In the case of a number of these small plants in which processes have been developed, and where the processes have now gone into the commercial scale of operation, the plants are still available, being located in small, temporary buildings around the Institute; such unit plants can often be adapted to the study of other new processes. The Institute is thus gradually acquiring what might be called a "large-scale equipment" that is undoubtedly unique in American laboratories.

Such, in brief, is the idea of the School of Specific Industries. It is not the intention to go out after students for this School, nor is it the intention ever to have very many students in the School, but it is believed that the proper sort of young men will seek its instruction.

WILLIAM H. NICHOLS MEDAL AWARD

The Nichols Medal, awarded by the New York Section of the American Chemical Society for the best original contribution to the publications of the Society during the year 1914, was conferred upon Dr. Irving Langmuir, of the General Electric Company Research Laboratory, in recognition of his distinguished researches on chemical reactions at low pressures, at the regular meeting of the Section, March 5, 1915.

The medal was presented by Professor Allen Rogers, Chairman of the Section. The addresses of presentation and acceptance are printed below, together with Dr. Langmuir's abstract of his paper on "Chemical Reactions at Low Pressure," presented in accordance with the rules for the award of the medal.

The Nichols medal was founded in 1902, and the eleven impressions made to date have been awarded as follows:

E. B. Voorhees	1903
C. L. Parsons	1905
M. T. Bogert	1906
H. B. Bishop	1907
W. H. Walker	1908
W. A. Noyes and H. C. P. Weber	1908
L. H. Baekeland	1909
M. A. Rosanoff and C. W. Easley	1911
Charles James	1912
M. Gomberg	1914
Irving Langmuir	1915

—[Editor]

IRVING LANGMUIR—WILLIAM H. NICHOLS MEDALIST, 1915

PRESENTATION ADDRESS

By Allen Rogers[1]

We are assembled this evening to do honor to a man whose wonderful achievement along scientific lines has very largely attributed to the developments in the high-efficiency tungsten lamp. We can hardly realize, as we enjoy our present day illuminations, that only a few years back our fathers read by the light of the tallow dip. It is such men, however, as Dr. Irving Langmuir, who by their untiring efforts have made this lighting system possible, and to them we owe a debt of gratitude which can never be repaid.

Dr. Langmuir was born in Brooklyn, New York, January 31, 1881. His early education was obtained in the public schools of that city which he attended until June, 1892, at which time his parents went to Paris; there he studied under French teachers for three years. Returning to the United States in the fall of 1895, he entered Chestnut Hill Academy at Philadelphia, and the following year found him in Brooklyn again, attending Pratt Institute. On completing his course at Pratt Institute he entered the School of Mines at Columbia University from which he was graduated in 1903 with the degree of metallurgical engineer. On finishing his course at Columbia we next find him doing post-graduate work at the University of Göttingen under Prof. Nernst, carrying out investigations on the kinetics of chemical reaction and on the dissociation of water vapor and carbon dioxide. In January, 1906, the degrees of M.A. and Ph.D. were awarded to him by the University of Göttingen, his major subject having been physical chemistry.

Returning to America Dr. Langmuir became instructor in chemistry at the Stevens Institute of Technology, where he taught until July, 1909. At this time he entered the research laboratory of the General Electric Company at Schenectady, since which time he has been engaged mainly in investigations on tungsten lamps and also to some extent in work on electric heating devices. Dr. Langmuir has been a frequent contributor to the various scientific journals, and on several occasions has appeared, before this section. Some of his contributions are the following:

"Thermal Conduction and Convection in Gases at Extremely High Temperatures."

"A Chemically Active Modification of Hydrogen."

"Chemical Reactions at Very Low Pressures—The Clean-up of Oxygen in a Tungsten Lamp."

"Chemical Reactions at Very Low Pressures—The Clean-up of Nitrogen in a Tungsten Lamp."

"Laws of Heat Transmission in Electrical Machinery."

"Conduction and Radiation of Heat."

"Dissociation of Hydrogen into Its Atoms."

To Dr. Langmuir:

Dr. Irving Langmuir, on behalf of the New York Section of the American Chemical Society, as a slight token of the appreciation and esteem in which you are held by your brotherworkers in the field of chemistry, I take great pleasure in presenting to you the William H. Nichols Medal and sincerely hope that your future efforts will be as fruitful as your undertakings have been in the past.

Pratt Institute, Brooklyn

[1] Chairman New York Section of the American Chemical Society.

ADDRESS OF ACCEPTANCE

By Irving Langmuir

Mr. Chairman: I deeply appreciate the honor that has been conferred upon me by the New York Section of the American Chemical Society, and I thank you for the kind words you have spoken.

The credit for the work upon which this award is based, should really be shared by many. In the first place, these investigations would never have been possible if it had not been for the active encouragement given by Dr. Whitney and for the wonderful spirit of coöperation and enthusiasm which he has instilled into the research laboratory.

In the second place, the work is the result of the very unusual ability of my assistant, Mr. Sweetser, who has carried out fully 90 per cent of all the experiments. Mr. Sweetser has made a quantitative study of a very large number of chemical reactions and other phenomena, and the data are preserved in the form of about 3000 large pages of notes which record all the details of the experiments. These data constitute a veritable mine of information on low pressure reactions. The results of only about one-fifth of the material have been published thus far. Gradually, I am working through the remaining four-fifths, trying to analyze the results and trying to develop theories of the phenomena observed. Besides Mr. Sweetser, there have been many other members of the laboratory who have actively contributed to this work. Among these I would mention especially Mr. Mackay and Mr. Rogers.

CHEMICAL REACTIONS AT LOW PRESSURES

By Irving Langmuir

If small quantities of almost any gas are introduced into an evacuated bulb containing a highly heated tungsten filament, it is found that the gas gradually disappears. In the great majority of cases this action proves to be of a purely chemical nature.

A large number of reactions have been studied quantitatively in this way, using many different gases and several different filament materials. In each case the actual rate was determined at which the gas disappeared, under given conditions of pressure, filament temperature and bulb temperature. Pressures ranging from 0.0001 to 0.05 mm. of mercury were employed.

The phenomena observed were studied from the view-point of the kinetic gas theory, and in this way it has been possible in the majority of cases to draw some more or less definite conclusions as to the mechanism of the reactions involved. In particular, the statistics of the reactions have been determined wherever possible. Thus, in a reaction between a gas and a solid body, the question is raised: Out of all the molecules which strike the surface of the body, what fraction enters into reaction with it? Similarly, in a reaction between gases, the question becomes: Among all the collisions between molecules of the two gases, what fraction results in combination?

The reactions occurring between heated filaments and the surrounding gases are heterogeneous. Reactions of this type have often been investigated in the past and several theories of the mechanism of such reactions have been advanced. The theory that has met with most favor is that of Bodenstein and Fink, according to which the velocity of the reaction is limited by the rate at which the reacting substances can diffuse through an adsorbed film of gases on the surface. The rate of diffusion is inversely proportional to the thickness of this film and the thickness of the film is in turn dependent on the partial pressure of the gas from which it is formed.

As a result of several years of study of heterogeneous reaction between solids and gases at low pressures, the writer concludes that under the conditions of these experiments, Bodenstein and Fink's theory does not apply. A new theory, which may be termed the "theory of molecular films," is proposed and is found extremely useful in all the low pressure reactions.

According to the "theory of molecular films" the velocity of heterogeneous reactions is in general limited by the rate at which the gas molecules can come into contact with the *active portion* of the surface.

The fundamental conception back of this theory is that the number of gas molecules which strike a given surface per second, according to the kinetic theory, is strictly limited at any given pressure. Thus, in a gas of molecular weight M at a pressure p, and absolute temperature T, the total number, n, of molecules which strike a sq. cm. of the walls per second is

$$n = 2.652 \times 10^{19} \frac{p}{\sqrt{MT}}$$

Here p is expressed in bars (dynes per sq. cm.). For air at room temperature and atmospheric pressure, this corresponds to about 2.9×10^{23} molecules per second; (in other words, 13.8 grams, or 12 liters of air per second).

Although this rate seems extremely high, yet if the *active surface* of the solid is very small the actual rate at which the gas is able to come into contact with it may also be small.

The portion of the surface which is active in a given reaction is in general determined by the *extent* to which the surface is covered by a layer of adsorbed gas. In some cases, the active surface is in the uncovered portion of the surface, while in others it may be the covered portion. The adsorption film is thus looked upon as a layer of molecules, usually only one molecule deep, which covers the surface more or less completely. This film is not thought to be a layer of highly compressed gas, as in

The William H. Nichols Medal

the usual theory of adsorption, but is considered to be a layer of molecules held on the surface by the same kind of forces as those that hold the atoms of a solid body together.

The adsorption film is taken to be in a state of kinetic equilibrium with the gases around it. Thus it is assumed that the majority of gas molecules striking the bare surface of a filament do not rebound from the surface by elastic collisions, but are held by cohesive forces until they *evaporate* from the surface. According to this view-point, which has been based on much experimental evidence, the rate of formation of the adsorption film is proportional to the pressure of the gas and also to the area of that part of the surface remaining uncovered. On the other hand, the rate of evaporation of the adsorption film is a function of the temperature and is proportional to the extent of the surface covered by the film. In a steady state the rate of formation and the rate of evaporation must be equal.

According to this theory, the adsorption film is in a state of constant change. One by one, the molecules are evaporating and thus exposing the bare surface of the metal of the filament. Other molecules then soon fill up these gaps, but at any given instant there will always be a certain small fraction of the surface exposed.

This theory of "molecular films" has been in good quantitative agreement with the experiments in all the cases studied thus far. In fact, examination of the published data on the velocity of heterogeneous reactions at ordinary pressures, makes it appear probable that even at these higher pressures this theory is more nearly in accord with the experimental facts than is the theory which postulates that the velocity is limited by the rate of *diffusion through* an adsorption film.

The application of this theory to particular cases will be considered more in detail in connection with the experimental results.

The experiments on the clean-up (disappearance) of gases by heated filaments have shown that there are many advantages in studying heterogeneous reactions at very low pressures.

In the first place, at low pressures convection currents in the gas are entirely absent and diffusion takes place so rapidly that the reaction products moving away from the filament, do not in any way interfere with the movement of the reacting gases towards the filament. In fact, at very low pressures the collisions between gas molecules become relatively so infrequent that one may consider the gas to consist merely of a swarm of totally independent molecules which move in straight lines between different points on the bulb and filament.

Under these conditions the temperature of the gas is determined by that of the bulb and there is no temperature gradient in the gas, in the ordinary sense, even very close to the filament. Thus the filament may react with a gas at a totally different temperature from itself—a thing impossible at ordinary pressures. A study of the effect on the reaction velocity, of the separate variation of gas temperature and filament temperature, opens up a new and powerful method for arriving at a better understanding of the mechanism of such reactions.

Another advantage in working at low pressures lies in the fact that the molecules of the products of the reaction, after once leaving the filament, do not return to it again until after having made many collisions with the walls of the bulb. If the bulb is maintained at such low temperature that the products condense, it is possible to prevent these products from coming into contact with the filament at all, except at the moment of their formation.

The reactions that have been observed in the clean-up of gases at low pressures may be divided into four classes:

1—The filament is attacked by the gas.

2—The gas reacts with vapor given off by the filament.

3—The filament acts catalytically on the gas, producing a chemical change in the gas without any permanent change in the filament.

4—The gas is chemically changed or reacts with the filament as the result of electrical discharges through the gas. These may be termed electrochemical reactions.

In this paper only a few examples of the first three types of reactions will be given. The consideration of the fourth type is reserved for a future paper.

1—DIRECT ATTACK OF THE FILAMENT

CLEAN-UP OF OXYGEN BY A TUNGSTEN FILAMENT—Even at very low pressures, oxygen attacks tungsten at high temperatures to form WO_3, which distils off the filament, leaving the surface clean and bright. A study of the rate of clean-up under various conditions and an analysis of the results from the viewpoint of the "molecular film theory" has led to the following picture of the mechanism of the reaction:

A large fraction (certainly over 15 per cent) of all the oxygen molecules striking the *bare* surface of tungsten sticks to the surface or is adsorbed, forming a layer which is probably only one molecule deep. This layer exists in two modifications which are in chemical equilibrium with each other. One of these modifications is *active* and reacts immediately with oxygen molecules which may strike it, to form WO_3, while the other is *inactive* and cannot so react with oxygen. For example, it may be that the oxygen is first adsorbed by the metal as WO_2, but that this reacts with more tungsten to form 2 WO, so that these two substances are in equilibrium with each other on the surface. Oxygen molecules striking WO would react to form WO_3, while those striking WO_2 would not react. The WO_3 distils off as fast as formed, but the rate at which the adsorption film evaporates is small, compared to that at which it is removed by combining with more oxygen.

This theory is in splendid quantitative agreement with the results of the experiments.

REACTIONS BETWEEN OXYGEN AND CARBON—At 1200° K,[1] part of the oxygen reacts with carbon to form CO_2 but another part gradually forms an extremely stable adsorption film which greatly retards the progress of the reaction that leads to the formation of CO_2.

At 1700° K the adsorption film slowly, and at 2100° K rapidly, decomposes in vacuum giving off CO. Thus when oxygen acts on a filament at 1700°, which has previously been heated in vacuum at a high temperature, at first only CO_2 is formed, but gradually, as the adsorption film grows, more and more CO is produced.

The adsorption film may also be formed by heating the carbon in CO_2. In this case the volume of CO liberated is equal to the CO_2 consumed, showing that half of the oxygen is retained by the carbon to form the film. Carbon monoxide, on the other hand, is not absorbed by the carbon at any temperature, showing that although the adsorption film gives up carbon monoxide on heating it cannot be formed from this gas.

There are good reasons for believing that this adsorption layer consists of oxygen atoms chemically combined with the carbon atoms forming the surface layer of the filament. These carbon atoms in turn form endless *carbon chains* or lattices with all the other carbon atoms of the filament.

According to this view-point it is not possible to assign a chemical formula to the oxygen "compound" on the surface. It is thought probable that the adsorption of oxygen by a tungsten filament at high temperatures is to be explained in a similar manner.

2—REACTION WITH VAPOR FROM THE FILAMENT

CLEAN-UP OF NITROGEN BY TUNGSTEN—It has been previously shown that nitrogen does not combine with solid tungsten, but that *every* collision between an atom of tungsten vapor and a molecule of nitrogen, results in the formation of the compound WN_2. In this case the temperature of the bulb is without effect on the velocity of the reaction.

CLEAN-UP OF NITROGEN BY MOLYBDENUM—A study of this reaction shows that nitrogen does not combine with solid molybdenum, and that *every* collision between an atom of molybdenum and a molecule of nitrogen results in the two "sticking" together, *sometimes* in the form of a stable compound MoN_2, but in other cases as an unstable "adsorption compound," which breaks up again when it strikes the bulb. The relative proportions of the *stable* and *unstable* compounds is dependent on the relative velocity of the nitrogen molecules and molybdenum atoms at the moment of their collision. The lower the relative velocity (lower temperature), the greater is the proportion of the stable modification.

CLEAN-UP OF CARBON MONOXIDE BY TUNGSTEN—With the bulb at room temperature this reaction follows exactly the same mechanism as the reaction between nitrogen and tungsten and leads to the formation of a compound WCO. On the other hand, *when the bulb is cooled below —70° C., the CO actually attacks the tungsten filament* and forms an adsorption film of this compound on the surface of the filament. The rate of attack of the filament is thus limited by the rate at which the compound can distil off, and is independent of the pressure of the CO or the bulb temperature (provided this remains below —70° C.). This is an interesting example of a chemical reaction having a reaction velocity with a negative temperature coefficient.

CLEAN-UP OF OXYGEN BY PLATINUM—This case is analogous

[1] K (Kelvin) is used to denote absolute temperatures.

to that of the clean-up of nitrogen by tungsten, but at higher pressures of oxygen (over 1 mm.), the oxygen in addition to combining with the vapor from the platinum, also attacks the platinum at a rate that increases with the pressure.

3—CATALYTIC REACTIONS

DISSOCIATION OF HYDROGEN INTO ATOMS—This has been fully described in recent papers in the *Journal of the American Chemical Society*.[1]

DISSOCIATION OF CHLORINE INTO ATOMS—A highly heated tungsten filament in chlorine at low pressures dissociates this largely into atoms. This leads to some interesting results. For example, consider two tungsten filaments mounted side by side in a bulb containing chlorine at low pressure. If one of the filaments be heated to a high temperature, while the other is kept cold, the *cold filament* gradually grows thinner and may finally disappear, while the hot filament may grow in size by the decomposition of the vapor of the WCl_6 formed by the attack of the cold filament by the atomic chlorine.

REACTION BETWEEN OXYGEN AND CARBON MONOXIDE IN CONTACT WITH PLATINUM—It is found that this reaction takes place only when carbon monoxide molecules strike oxygen molecules which are present in an adsorption film on the surface. At low temperatures the carbon monoxide adsorbed on the surface prevents the oxygen molecules from being adsorbed. As the temperature is raised, the carbon monoxide evaporates more rapidly and thus exposes the bare surface of the platinum. The oxygen and the carbon monoxide molecules then compete with each other to reach these bare spots. If oxygen strikes such a spot it is adsorbed and thus reacts with the next CO molecule which strikes it.

At higher temperatures the CO and O_2 distil off more rapidly and finally a point is reached where the velocity of the reaction decreases with further rise in temperature because the oxygen adsorbed on the surface distills off before the CO molecules have a chance to react with it.

The experiments at all temperatures and pressures are in good quantitative agreement with this theory.

REACTION BETWEEN OXYGEN AND HYDROGEN IN CONTACT WITH PLATINUM—The mechanism of this reaction is very similar to that of carbon monoxide and oxygen.

RESEARCH LABORATORY, GENERAL ELECTRIC COMPANY
SCHENECTADY, NEW YORK

CURRENT INDUSTRIAL NEWS

By M. L. HAMLIN

GAS PROGRESS IN THE UNITED STATES

In a speech before the convention of the "Investment Bankers' Association of America" on "The Modern Gas Company as Security for Bonds" (quoted in the *J. Gas Lighting*, **129** (1915), 212), Rufus C. Dawes of Chicago outlined the growth of the gas industry in this country.

As early as 1835 there were at least six gas plants in the largest cities of the United States, and the business may be considered as well established at that time. The oldest tradition of the business is to maintain an uninterrupted supply of gas. It was a proud advertisement made by the Consolidated Gas Company that "New York City's gas supply has never failed in eighty-seven years." But it is substantially true of all gas companies. This determination to establish a dependable service has had no small part in the development of the business, for the gas business has, from the start, had many things to contend against. The inventive genius of mankind has exhausted itself in an effort to supply some substitute for the service it has rendered; but, in spite of many obstacles, and contrary to many fears, the gas industry has steadily grown. The obstacles have been overcome. The fears have subsided. The industry has entered a new era, and has more than doubled its volume of business in the last decade. Invention now works for, not against, its future growth. The price at which its product has been sold has steadily declined. In New York City, for instance, the price in 1826 was $10; in 1846, $6; in 1866, $3.50; in 1886, $1.25; in 1906, $0.80. Each reduction in the selling price of gas has opened up new fields for its use.

Gas carries heat units in a form more available for use than any of its competitors. Whenever a new field is invaded, the genius of inventors perfects the methods of burning gas; and the demand for such inventions has only recently been felt. The response is most encouraging, and the double effect of lower prices and more efficient burners has already been apparent, and supports the strongest confidence for further success in the heating field. Herein lies our future; and we are not so far as some have supposed from our great goal—the use of gas exclusively for domestic heating.

Bonds issued by modern gas companies are secured by a natural monopoly in the sense that their property is the only one capable of supplying exactly the same service. Moreover, under present legal adjustments, which provide for regulation and control with due regard to the protection of money invested, such property can never be duplicated or abandoned, but must be devoted to supplying this service, exclusively and perpetually. Yet these companies are engaged in the greatest of competitions—the competition of fuels. At least we have at last learned to conduct our business in this conviction; and we do believe that we can deliver the elusive and highly prized heat units in safer, cheaper, and more available form than our competitors, for an annually increasing number of purposes.

In support of our confidence, I may submit some statistics compiled by Mr. John W. Lansley, from a United States Government report relating to the gas industry. These figures are the best available, and appear to be substantially correct:

Year	Plants	Capital	Annual product
1850	30	$ 6,674,000	$ 1,921,746
1890	742	258,772,000	56,987,000
1900	877	567,001,000	75,717,000
1910	1,296	915,537,000	166,814,000

Between 1890 and 1900 the increase in capital appears, from these statistics, to be 119 per cent, while the increase in annual gross income appears to have been only 33 per cent. Between 1900 and 1910, on the contrary, capital appears to have increased 60 per cent and the annual gross income 120 per cent. The increase in the amount of capital between 1890 and 1900 was about the same as between 1900 and 1910, but the increase in income between 1900 and 1910 was five times that between 1890 and 1900. This increase in gross annual income was brought about by a reduction of 32 per cent in the price at which the product was sold. In other words, a gradual reduction of 32 per cent in the price of the product resulted in ten years in an increase of 120 per cent in the gross annual revenue of an industry eighty years old, and necessitated an increase of only 60 per cent in capitalization.

The most interesting incident in this extraordinary accomplishment is the increase in the consumption of gas for fuel purposes. It is difficult to determine these proportions accurately, but the United States Geological Survey gives figures from which it may be estimated that in 1900 the proportion of gas used for fuel was about 20 per cent of the total, and in 1910 about 50 per cent. From these conditions and these tendencies

[1] Langmuir and Mackay, *J. A. C. S.*, **36** (1914), 1708; and Langmuir, *Ibid.*, **37** (1915), 417.

may it not be safely predicted that the future of the gas industry is secured?

As a basis for bonds, the modern gas company offers, then, these conditions: A stable income for the supply of a public necessity, an increasing income, physical property exceptionally high with relation to income and permanently devoted to public service, moderate and not extortionate profits, a long record, excelled by none, and a present condition of growth never before experienced.

LOW-TEMPERATURE COAL DISTILLATION

In his second Cantor Lecture, on "Oils, Their Production and Manufacture," before the Royal Society of Arts [*J. Gas Lighting*, 129 (1915), 260], Dr. F. Mollwo Perkin referred to the hopes which have been expressed from time to time, of obtaining large quantities of motor spirit from coal by low-temperature distillation.

Those who have designed retorts for this purpose, he said, have been extravagant in their anticipations; and there has been too much loose talk of phenomenal yields of motor spirit. The fact is that methods of distillation have not been sufficiently studied, with the result that crude products have been spoken of as if they were purified products. Coal owners and others who have subjected their minerals to distillation in various retorts have consequently been considerably disappointed. Personally, he believed in a very great future for low-temperature distillation, but care should be taken not to exaggerate. Many of the enormous claims made out for the production of motor spirit in this way could, on examination, be reduced to one-third.

The best-known processes for producing motor spirit of this kind are the Coalite, the Del Monte, and the Tarless Syndicate—one of the objects being the production of a smokeless fuel. There is not always a good market for this kind of fuel, but there is an increasing market for the other products of the processes—*viz.*, various oils and sulfate of ammonia.

One drawback of the Del Monte process originally was that the retort quickly became blocked up if a caking coal was used, but a form of retort has now been designed in which any kind of coal could be used. Results with a Scottish cannel coal, which contained some 31 per cent of volatile matter, showed a yield of 37 gallons of crude oil per ton—the smokeless fuel remaining behind containing 9 per cent of volatile matter. The crude oil on fractionation gave 1 gallon of motor spirit, 3 gallons of fuel oil, 16.9 gallons of heavy oil, 3 lbs. of wax, and 124 lbs. of pitch. This showed how purification reduced the quantity of oil available for motor purposes.

The Tarless Syndicate's process works on a totally different principle, and produces a good smokeless fuel. Caking coals can be used very readily. With this process, a Yorkshire coal containing $29^1/_2$ per cent of volatile matter gave 18 gallons of crude oil per ton, which, on purification, yielded 3 gallons of motor spirit, $2^1/_4$ gallons of intermediate oil, $8^1/_2$ gallons of fuel oil, 8 lbs. of paraffin wax, 50 lbs. of pitch, and 22 lbs. of sulfate of ammonia. It is possible, with the smokeless fuel from this process, to light a fire without any ordinary coal, which is not the case with all smokeless fuels.

BRITISH OIL IMPORTS

In a recent issue the *J. Gas Lighting* [129 (1915), 181] comments editorially on data of British oil imports in 1914 published by the *Petroleum Review*. Far from the war having adversely interfered with the petroleum trade it appears to have beneficially affected it. Last year Great Britain imported not less than 459,744,780 gallons of various petroleum products, exclusive of the large amounts absorbed by the British Government, which may be calculated to aggregate about 200 million gallons. The European war has, of course, interrupted supplies from certain eastward fields. Owing to this fact, owing also to important Continental countries being closed to outside trade, America has taken advantage of its free way to this country, and has made the most of its opportunity; and it is easy to agree that, had it not been for the amplitude of the American supplies, England long ere this would have been in a very unfortunate position. The gas oil trade is now almost exclusively with America; and there is indication of the large revival of carbureted water-gas manufacture, after the shutting-down of plants, due to oil costs, in 1912 and the first part of 1913, when it is learned that the gas and solar oil imports from America last year established a new record—amounting in the aggregate to 83,000,000 gallons. This figure is in the neighborhood of 20,000,000 in excess of the total for 1912, and 18,000,000 in excess of the total for 1913. Notwithstanding the growth of the prepayment gas-meter system, the illuminating oil trade has still very large proportions, though the constant inroads upon it are causing its bulk gradually to dwindle. When one sees that the imports of illuminating oil during the past twelve months amounted to 146,600,000 gallons (which was some 10 millions less than in 1913), it suggests that (not forgetting the use of oil for illumination in other directions) the prepayment gas-meter has still an extensive field to conquer. The *Petroleum Review* admits that during recent years the tendency has been towards a diminished consumption of oil for illuminating purposes. "But now that kerosene can be so advantageously employed for heating and cooking purposes, and its use as an illuminant under modern conditions is regaining favor, there is no doubt that a steady increase will be shown in the illuminating oil imports for many years to come." There is good confidence, says the editorial, in saying that such a messy method as cooking and heating by oil will not gain much headway with cleanly, convenient, labor-saving, and economical gas opposing. Of course, there is an increasing use of oil for internal combustion engines. Motor spirit imports also showed an enormous gain during the past year. Altogether 120 million gallons were imported, or about 18 millions more than in 1913. So long as the gas industry continues to make headway, it can afford to congratulate a companion industry upon its successes, even though that industry may be largely competitive.

PETROLEUM OUTPUT OF ROUMANIA[1] IN 1913

TOTAL OUTPUT (METRIC TONS) IN 1913	1,885,225	
	Metric tons	
EXPORTS	1912	1913
Crude petroleum	27,498	28,622
Residues.......	283,594	341,912
Mineral oils....	7,351	9,543
Gasoline.......	353,563	418,622
Benzine........	173,817	237,168
Paraffin........	600	579
TOTAL EXPORTS.	846,423	1,036,446

EXPORTS TO	Metric 1912	tons 1913
Germany......	84,041	126,295
Great Britain...	214,195	232,880
Austria Hungary.........	86,013	77,184
Belgium.......	11,907	25,136
Bulgaria.......	10,358	13,149
Denmark......	4,500	13,893
Egypt.........	142,418	121,642
France........	163,679	151,402
Holland.......	26,036	44,947
Italy..........	25,921	118,643
Norway.......	11,343	8,186
Russia........	1,210	9,114
Tunis.........	7,053	8,204
Turkey........	53,549	64,682
Sweden........	.....	4,190

COAL TAR IN RUSSIA

The supply of coal tar in Russia has, says a Petrograd correspondent in the *J. Gas Lighting* [129 (1915), 184], become a very acute question since frontier communications between Germany and that country have been closed. The only gasworks that hitherto has made a feature of distilling its own coal tar for chemical purposes to any extent has been that of Warsaw. Moscow had realized the importance of directly utilizing the residuals of gas production, and had entered into a contract with a German house to supply a plant for the recovery of

[1] *Chem. Ztg.*, **39** (1915), 28.

ammonia. But difficulties having supervened in consequence of the war, there is said to be a probability that, in the event of some home house not being found capable of carrying out the work, the contract will ultimately be confided to a firm in England or in a country on friendly terms with Russia. A good deal more coal tar could be obtained by the Russian gas-works, were the industry more alive to the value of using up the raw material that lies close at hand. But hitherto either the raw material itself or its derivatives—such as aniline dyes—have been obtained almost entirely from Germany. The present crisis is forcing attention to what the gas-works can do for the country; and it is believed the result will be a much larger call on these establishments for coal tar and other by-products of value in the chemical industry.

ACTIVITIES OF THE BRITISH BOARD OF TRADE

Shortly after the outbreak of hostilities, the Commercial Intelligence Branch of the British Board of Trade issued a series of pamphlets dealing with the exports and imports of Germany and Austria-Hungary, and comprising extracts from Consular reports bearing on the articles of industry of which statistics were given. Much of the matter was old, but the reissue of it has helped to focus the attention of the manufacturer on the items which concern him individually.

ARTICLES WANTED BY BRITISH FIRMS

Glass artificial fruit	Aniline or pulp dyes	Permanent magnets for magnetos
Bakelite	Sulfur black	Gold metal foil
Brushes, misc.	Electrical insulating materials (such as ambroin, stabilite, aetna material, etc.).	Zinc sheets (nickel-plated and polished on one side)
Celluloid substitute	Milk powder	Solid drawn steel tubes about 2 in. internal diam. and 24 ft. long
Cement and plaster	Galalith	Lanoline (anhydrous)
Cellulose acetate	Galalith substitutes	Asbestos fiber jointing
Salicylic acid	Glass cylinders for vacuum flasks	Japanese toilet paper
Bichromates of soda and potash	Presses for stamping thin sheet metal	Imitation Mother-of-Pearl paper
Antimony	Machinery for winding fine wires on bobbins, and for twisting wire around gut musical strings	Waterproofing paste and solutions
Barium peroxide		Zinc dust
Manganese dioxide		
Sodium salicylate		
Bisulfite of soda		
Hydrosulfite of soda		
Aceto-salicylic acid		
Eau de cologne		
Alizarine substitute		
Aniline		

ARTICLES WANTED BY NON-BRITISH FIRMS

Balata belting	Copper sulfate	Chinese wood oil
Corozo and imitation buttons	Protosulfide of copper	Degras
Horn and bone buttons	Aniline colors	Earth wax
Celluloid sheets	Dyewood	Linseed oil
Chromic and muriatic acids	Indigo	Paraffin
Arsenic	Rotary kilns for making Portland cement	Turpentine
White lead	Machinery for cutting leather boot laces	Cinnabar
Sodium citrate	Machinery for making pins, hair pins, hooks and eyes, and similar articles	Fluorspar
Naphthalene	Aluminum sheets	Talc
Formalin	Cellular zinc sheets, for making perforated cylinders for seed cleaners	Dividivi
Antimony		Extracts (especially liquid quebracho, oak and chestnut)
Quicksilver		Mangrove extract
Ammonium nitrate		Quebracho
Sodium oxalate		Tannin
Red lead		Zinc
White zinc oxide		Zinc dust

In connection with this campaign undertaken by the Board of Trade to assist manufacturers and merchants to secure trade formerly in the hands of German or Austria-Hungarian firms, a series of lists are being published weekly, dealing with inquiries for articles which inquirers desire to purchase. The February lists are given above.—[E. GEDDES ANDERSON]

THE PURIFICATION OF PETROLEUM

According to *The Petroleum World* (Vol. No. 173), the sulfuric acid method for the purification of petroleum is generally regarded as being expensive, and unsatisfactory in some respects, and chemists have spent much time and money in the endeavor to find a more efficient and less troublesome method. A new method in which the mineral bauxite replaces the sulfuric acid is described, and it is stated that the Burmah Oil Co., Ltd., are using this bauxite method, with success, at their refineries at Rangoon. The description goes on to state: "The Indian varieties of the ore are particularly efficient, and many experiments carried out with petroleum products from all parts of the world, including waxes from oils, show this variety of bauxite to be as effective as it has been with the Burmah oil products. The bauxite must be graded in the same way as is fuller's earth, and this is best done by the supplier. The bauxite in its natural state has little effect on coloring matter, or other purifying action, until the water of combination has been driven off at about 500° C. To accomplish this the bauxite is calcined in any suitable furnace, and is then ready for use in the filters. By filtration it will be apparent that the wax or oils may be graded into several degrees of colors; that passing first through the bauxite is colorless, whereas that passing through later is slightly tinged, increasing in color until the bauxite is exhausted. By grading the wax or oils, the process can be carried on, and the full efficiency of the medium used up. After the decolorizing power is completely exhausted, the bauxite containing a certain amount of the wax or oil is extracted in any suitable extraction plant, steam-dried and ignited, when it is again ready for use. There is not much mechanical loss in these operations, although much depends upon the physical nature of the original mineral, some varieties being very soft and easily powdered. It is best to select a variety possessing a good degree of hardness.—A.

METER-TESTING IN CANADA

A Canadian Blue Book which has lately been issued furnishes particulars in regard to the testing of gas-meters in the year ending March 31, 1914. The number presented for verification was 88,133, of which 23,641 were correct, while 16,253 were fast and 47,400 slow within the legal limit. Altogether 87,295 meters were verified and 838 rejected.

THE AMERICAN LOCOMOTIVE INDUSTRY

Figures relating to recent locomotive construction in the United States are of rather peculiar interest at the present time, according to *Engineering*, 99 (1915), 146, in view of the efforts made in some quarters to hold Great Britain and the action of our Fleet responsible for the business depression on the far side of the Atlantic. In 1914 there were built in the United States only 1265 locomotives, compared with 5332 built in the previous year. It is very clear from these figures that, supposing no engines to have been built after the outbreak of war, the industry was badly depressed throughout the first half of the year. England cannot have had much to do with causing a depression which was really serious before the international complications of the latter half of the year. Its real cause is rather to be found in the country itself, and so far as the railways are concerned, is due largely to the harassing manner in which they have been treated in recent years. The effect of disturbing the purchasing power of so large an industry as the railways is felt, of course, throughout the country.

THE GERMAN IRON-UNION NEGOTIATIONS

The different branches of the German iron industry have just been holding a number of meetings in order to discuss the present position and the outlook [*Engineering*, 99 (1915), 183]. As regards the plate-rolling mills, it was held that it was necessary to raise the quotations, on account of the increasing cost of manufacture. No definite arrangements, at least as far as inland sales go, were, however, arrived at, but the works agreed that during the war, and in the meantime until the end of June, all sales abroad should be made jointly through one bureau—that of the Shipbuilding Steel Bureau, at Essen, which was formed after the dissolution of the former heavy-plate union. The report that the bar-iron works had arrived at an understanding on the basis of the former bar-iron union agreement is not correct. At the meeting of the steel works the market position of the "B" products was gone into, more especially with reference to bar iron, and the opinion was generally expressed that higher prices would have to be insisted upon, and for the first quarter of 1915 a price of $112^1/_2$ marks net, Oberhausen, was suggested, and for the second quarter a price of 115 marks. No binding arrangement, however, was arrived at, and there is no question of anything like a substitute for the old bar-iron syndicate having come into existence. There has been a discussion about price agreements concerning the three leading "B" products, bar-iron, plates, and tubes as a kind of intermediate step to the contemplated proper syndicate. It appears at present questionable whether such an arrangement can be arrived at on account of the dislike for conventions of this kind which prevails in many industrial circles. The plate-rolling mills, in any case, as has already been mentioned, have decided not to go beyond an arrangement about the export business, which cannot be of much importance at present; for bar-iron syndicate negotiations may be said not to have commenced yet.

THE "SENFROT" CHEMICAL INJECTOR

An interesting piece of machinery for introducing a fixed ratio of chemical solution (as, for example, a coagulant like aluminum sulfate) into a water supply system under pressure is the "Senfrot" injector invented by the English engineer R. C. Parsons. It will work with water under any pressure [*Engineering*, 98 (1914), 699].

The accompanying figure is a section through the two pump cylinders and the main into which the solution is to be introduced.

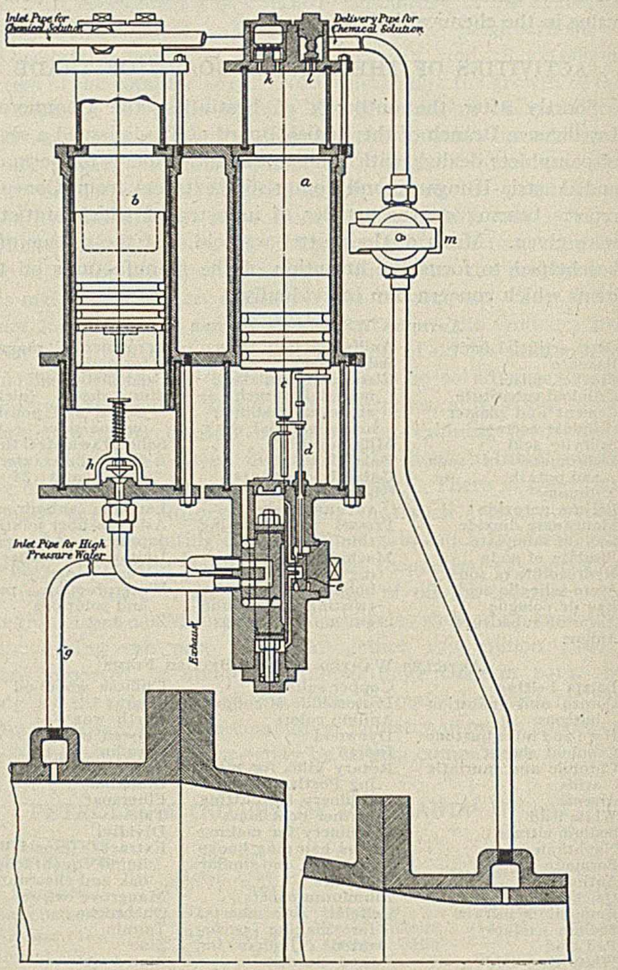
The cylinders are of equal diameter, and are always full of water, or of water and the chemical solution which is to be injected into the mains. Each cylinder contains a solid piston, made of material slightly heavier than the liquid displaced. The pistons, which have wide circumferential grooves, move quite freely in their cylinders. A valve-gear, which controls the admission and exhaust of the water from both cylinders, is situated below the cylinder *a*. It is operated by a fork carried by a rod, *c*, attached to the bottom of the piston of the cylinder *a*. This fork engages the tappet-rod *d*, which has adjustable tappets, and by means of it moves the slide-valve *e* each time the piston completes a stroke in either direction. The operation of this slide-valve *e* controls the movements of a second slide-valve *f*, by admitting pressure-water above or below it. The casing of the valve *e* has a connection to the pressure-main through the pipe *g*, and a further connection to exhaust.

Slide-valve *f* is cylindrical, and in that sense is a piston-valve; but it has ports only on one side, like a slide-valve. The object in using the cylindrical construction is to enable the valve to operate like a piston and to move up or down as pressure water is supplied below or above it by the movement of the valve *e*. The movement of the valve *e* admits water alternately to each end of the valve *f*, and simultaneously puts the other end to exhaust. The ports in the valve *f* are so arranged that, as it moves up and down, it alternately supplies pressure-water to the cylinders *a* and *b*, and at the same time connects the other cylinder to exhaust. In addition to the valves *e* and *f*, there is a further controlling valve, *h*. This is fixed at the bottom of the cylinder *b*, and is kept open by means of a spiral spring, except when it is forcibly closed by the piston, in its lower position, coming down on top of the spindle. There are further valves fixed in casings at the top of the cylinders which control the chemical to be injected into the water-main. The valves of the two cylinders are similar, and in the figure the arrangement for the cylinder *a* is shown in cross-section; the inlet and outlet valves are respectively marked *k* and *l*. All the valves consist of thin discs of pure soft rubber.

The solution to be injected into the main is stored in a tank above the apparatus, connected to the upper valve boxes of the cylinders by the pipe shown in the figure. The delivery pipe from these valves to the main has in it a valve *m* with a diamond-shaped orifice which does not alter its form when opened or closed so that a practically constant coefficient of flow is maintained.

Another essential part of the apparatus is a Venturi tube in the main, indicated by two broken parts at the bottom of the figure. The delivery pipe for the solution enters this at the point of least pressure, while the supply pipe for working the pumps is attached at the point of maximum pressure.

In action the water raises the pistons on the up-stroke because of the difference in pressure above and below, due to the Venturi Throat, and the down-stroke is caused by the relief of pressure from opening the exhaust pipe to the atmosphere. In the



cycle the valve *s* controls the movements of the valve *f* exactly as the slide valve of a steam engine controls the piston; *f* in turn controls the flow of water to the cylinders.

The stroke of the piston *a* is constant, while that of *b* depends on the rate at which the injector is working.

An apparatus with cylinders 3 in. in diam. × 4 in. stroke can inject 70 gallons an hour against any pressure. The apparatus as described is accurate with a range of flow in the main from 1 to 13 and in the injected solution from 1 to 10. Since, however, variations in flow in the main of from 1 to 30 are not in practice, a variable Venturi tube has been designed to allow for this. This device and other auxiliaries are described in detail *loc. cit.*

IRON PRODUCTION IN NORWAY

A leading Norwegian technical journal strongly advises Norway to take up the manufacture of iron on a sufficiently large scale to supply her own wants according to *Engineering*, 99

(1915), 208. The belligerent countries—England, France, Belgium, Germany—when the war is finished, will require immense quantities of all kinds of metals, especially iron, for which much ore will have to be imported from abroad, with sundry freight and transport expenses, before it reaches the works. It certainly used to be an accepted maxim that ore should be conveyed to the coal deposits, and not *vice versa*, but a different view now begins to prevail, and modern iron works started in the ore districts have recently shown more rapid development than where the reverse plan has been adopted. Norway has immense deposits of iron ore. The South Varanger concentrate contains 65 per cent iron, and is considered one of the world's finest ores; and good Swedish ore can, of course, also be obtained at an advantageous price. As these are too rich to be used without addition of poorer ores, some of Norway's deposits of this type may become useful. Of limestone, there is sufficient in the country, as is also the case regarding materials for lining the furnaces. The mining of coal at Spitzbergen is likely to develop greatly, and a large coking plant is under consideration in Northern Norway. Discarding for the present electric ore-smelting, the adoption of the ordinary blast furnace of up-to-date design, and with coke, is recommended. Iron ore will be cheap wherever in Northern Norway the iron works are placed, at Norvick, or perhaps further north. The installation should be on a comparatively large scale, as the consumption of iron is rapidly increasing, from 40 lbs. per individual in 1870 to 117 lbs. in 1900, at which date the consumption in Germany already exceeded 220 lbs. per inhabitant. A production of 100,000 tons of pig iron per annum is considered the minimum, of which quantity half might be used for foundry purposes, and the other half at steel works. Apart from the home market, one might reckon with the neighboring countries—Sweden, Russia, Finland, and Denmark. An installation of two blast furnaces, with a capacity of 50,000 tons each, is suggested, and, in addition, basic Martin furnaces or Bessemer, rolling-mill, etc., besides power-station and quay accommodation on the railway. The cost is calculated at about $1,750,000, but it is confidently prophesied that this outlay will bear good fruit, and enhance Norway's independence industrially.

GLASS AND PORCELAIN FOR LABORATORY USE IN GREAT BRITAIN

At a recent meeting of the Society of Chemical Industry, an exhibition was held of laboratory apparatus, formerly mainly produced abroad, but now being manufactured within the United Kingdom. After the inspection an opportunity was given for discussion. It was stated that the difficulties in connection with the production of laboratory glass were very great but that the British Laboratory Association, after some months of labor, were now able to submit a glass which they hoped within the next six or seven weeks to be able to put on the market at a very reasonable price and equal to Jena glass for laboratory purposes. The same remarks applied to porcelain. The materials before being put on the market would be subjected to severe tests and Dr. Cope of Cambridge and other Cambridge university professors had offered their services in regard to the testing of the materials. The question of optical glass was raised and it was pointed out that this was now being worked on.—A.

PICRIC ACID EXPLOSION

A report, by the Chief Inspector of Explosives, upon an explosion of picric acid at the factory of Ellison, Ltd., at Heckmondwike, has been issued by the English Home office. The inspector is of the opinion that the ignition of the picric acid occurred in the sifting shed, and was probably due to the accidental presence in the grinding mill of a nail, stone, or other hard foreign substance and that the resultant explosion was not owing to the presence of a picrate, nor to the inherent properties of the picric acid, but was rather an explosion of carbonaceous dust, rendered more than usually violent because it contained within itself all the elements necessary to form an explosion. He attaches no blame to Messrs. Ellison, but in consequence of the accident he has requested all licensed manufacturers of picric acid in the United Kingdom to discontinue the process of dry grinding and adopt some method of dealing with abnormally large crystals in a wet state, and further to take preventive methods as far as practicable against the formation of fine dust during the operation of sieving.—A.

GOLD FOIL AND GOLD LEAF

According to *The Paper Maker* (49, No. 2) the manufacture of gold foil and gold leaf for the embossing of book covers, etc., has largely if not entirely been a German monopoly, but a Manchester firm which does a large business each year in embossing, etc., has now obtained the sanction of the Board of Trade for the entire use of a German patent for the manufacture of these two requisites.—A.

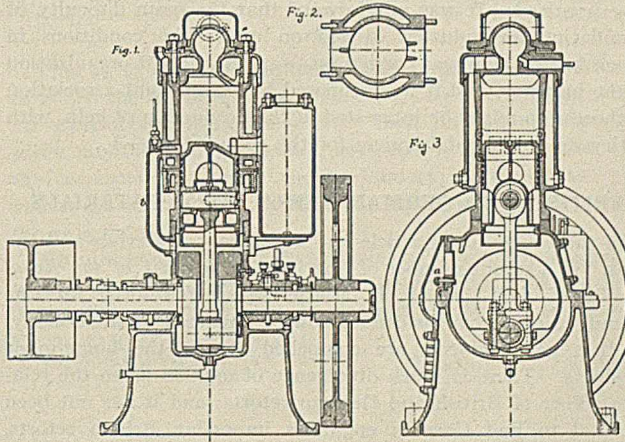
INDIGO CONFERENCE

At a meeting of the Supreme Legislative Council of India Revenue Minister replying to a question said: "Natural indigo has undoubtedly suffered severely from competition with the synthetic product, and the Government of India are at present considering to what extent, and in what manner assistance can be rendered to growers of indigo. A conference has been arranged to be held at an early date at Delki, to consider the question."—A.

TWO-CYCLE DIESEL ENGINE

A type of two-cycle Diesel engine built in units as small as 9 H. P. at 475 r. p. m., designed for heavy duty such as agricultural and shop work, is described in *Engineering*, 99 (1915), 187. In appearance the engine is simple and workmanlike.

The scavenging air is drawn in through a grid in the base, passes through the passage *a* to the crank case, where it is compressed, and at the end of the stroke expands through *b* into the cylinder and finally into the muffler. The piston is of the long trunk type with five rings and a heat-insulating air chamber which protects the gudgeon pin from overheating. The governor



is contained in the belt pulley and acts on the fuel supply by altering the throw of the eccentric driving the fuel pump, the eccentric working on a skew cylinder on the shaft.

The cylinder and head are interesting. The head is fixed to the cylinder but fits over the jacket walls, with which the joint is made by means of a rubber ring, as in the jacket of gas engines. Thus independent expansion of the cylinder and jacket is provided, and only one metal-to-metal joint between the cylinder casting and head has to be made. The head is water-jacketed. It contains a moderately wide neck, opening out for the bulb, which is a separate dome-shaped casting. The hot bulb is not bolted down, but is held down by the cover, which forms a ring pressing evenly all round on the flange of the hot bulb. These features have contributed very considerably to the complete elimination of hot-bulb failures, so common an occurrence in some engines of the two-cycle type. Another interesting point often overlooked is the desirability of placing the scavenging and exhaust-ports in line with the crank-shaft. It will be seen from our illustrations that this is done in the engine under notice. Often they are placed on a line at right angles to the shaft, and therefore reduce the area of the wearing-face provided in the cylinder for the piston at a point where the thrust is severe. Fig. 3 is a section taken across the ports.

The engine illustrated in the figures thus far referred to is, as already stated, of 9 brake horse-power capacity. Two other single-cylinder engines of this type are built—*viz.*, 16 and 25 as brake horse-power. The former has a cylinder 9 in. by 11 in. and the latter one $10^1/_2$ in. by $12^1/_2$ in. The speed of the former is 375, and of the latter 300 revolutions per minute. These two engines are similar to that described in general details, except that they have outside pedestal bearings, the fly-wheel being keyed to an extension shaft bolted to the main shaft by flanged couplings. There is an 18 horse-power engine of the twin-cylinder type, with fly-wheel on a shaft extension and pedestal bearing. The whole is mounted on a separate base-plate. The two cylinders are 7 in. by 8 in., and the speed 475 revolutions per minute.

NITRO-CELLULOSE

A Government white paper recently issued states that Mr. J. M. Thomson and Mr. W. F. Thomson, respectively the manager and chemist of the Royal Gunpowder Factory, have been awarded a sum of L. 2,850 for improvements brought about in the manufacture of nitrocellulose.—A.

KELP INDUSTRY

The British Board of Agriculture are at present taking up the question of the revival and extension of the kelp industry in Scotland. A deputation from the North of Scotland was received at the offices of the Board of Agriculture, and the matter was discussed. It was put forward that the main difficulty of stimulating an industry carried on under the conditions in which kelpmaking was carried on, was the actual organization of the industry, and it was proposed to form a joint association of those who might be interested in the production of kelp, with a view to securing fair prices for the commodity.—A.

BRITISH AND GERMAN REFRACTORY MATERIALS

In the course of an article on "Refractory Materials and the War," in a recent number of the English *Journal of the Royal Society of Arts*, Dr. A. B. Searle says: "Retorts for the manufacture of coal gas cannot now be imported from Germany, so that gas engineers are compelled to use the home-made products. There is much divergence of opinion as to the relative values of British and German retorts; and it has not been unusual to find German engineers importing British retorts, while some British engineers have preferred to purchase German ones. Here again British manufacturers are trying to meet the demands as far as they are able. The chief difference between British and German refractory materials may be traced to the difference in the ownership and management of the firms. In this country refractory materials are chiefly made by men who have worked themselves up from a small beginning, or the descendants of such men, their chief characteristic being that of a workman whose knowledge and experience have been gained almost entirely in the workshop, and whose theoretical knowledge—whether of chemistry, physics, or mechanics—is almost negligible. The German manufacturers of refractory materials, on the contrary, have almost invariably had a sound training in chemistry and engineering. They approach the manufacture from an entirely different point of view—*viz.*, that of the user turned manufacturer. Consequently they are more impressed with the needs of the user, while the British manufacturer is chiefly impressed with the difficulties of manufacture and the limitations imposed by his material. If once this bias could be overcome—and the only remedy is the better education of the manufacturers—there is no question that better refractory goods can be made in Great Britain than can be obtained from the Continent for the same price."

GERMAN IRON AND STEEL

According to a statement by the Union of German Iron and Steel Industries quoted in *Engineering* [99 (1915), 204] the production of pig-iron within the German Customs Union for December, 1914, amounted to 853,881 tons, against 1,611,250 tons for December, 1913, or not very much more than half, while there was an improvement as compared with November, 1914, for which the figure was 788,956 tons. The production of pig iron has been as follows:

1914	Tons per day	District	Tons Total
August	18,925	Rhineland-Westphalia	395,600
September	19,336	Siegerland, Wetzlar, and Hessen-Nassau	52,172
October	23,543	Silesia	61,166
November	26,299	North Germany	14,830
December	27,545	Central Germany	25,299
December	Tons Total	South Germany and Thuringia	15,473
Foundry pig	148,881	Saar district	53,554
Bessemer pig	8,778	Lorraine	124,464
Thomas pig	542,808	Luxemburg	111,323
Steel, etc.	128,317		
Puddle	25,097		

More especially in the last three districts the production shows a considerable increase of late.

The aggregate production for the last two years was:

Tons	1913	1914
Foundry pig	3,657,326	2,494,527
Bessemer pig	368,840	237,988
Thomas pig	12,193,336	9,289,989
Steel, etc.	2,599,887	1,996,786
Puddle	489,783	370,257
Total	19,309,172	14,389,547

The reduction in the production was, as might be expected, most marked in Lorraine, with Luxemburg, and next in Rhineland and Westphalia, while less pronounced in Silesia. The figures were:

Tons	1913	1914
Rhineland and Westphalia	8,209,157	6,610,119
Lorraine and Luxemburg	6,417,727	4,267,573
Saar district	1,370,980	954,738
Silesia	994,604	853,957

The Essen Pig-Iron Union, according to the present arrangement, is to go on until the end of the year 1917 (*vol. cit.*, p. 146). The allotment of 1912—*viz.*, 2,788,000 tons—was raised on account of some additional works joining, the figures of allotment for last year being 2,840,796 tons, which aggregate also holds good for the present year, whereas the figures for 1916 and 1917 were fixed, respectively, at 2,955,796 tons and 2,985,796 tons. It now remains to be seen how the war will affect the actual output. The increase is not brought about by a proportionate general rise, but is rather confined to comparatively few concerns, and some few works have dropped out, or are disappearing, at the end of the current year. Thus the Haigerer Hütte and the Bochumer Union do not figure in the list for 1916, the former withdrawing, and the latter having sold its allotment to the Gelsenkirchener concern, while a couple of works disposed of their allotment to the Pig-Iron

Union at a price of 3 marks per ton. Including these, the original list for the current year comprises thirty-eight concerns, of which the largest allotments (in tons) for 1915 are those of:

Gelsenkirchener Co.	234,483	Van der Zyppen-Wissen Co	106,592
Lübeck Blast-Furnace Co.	167,500	Buderussche Iron Works	105,000
German Luxemburg Co.	163,000	Gutehoffnungshütte	101,197
Kraft Kratzwjeck Co.	160,000	North German Iron Works, Bremen	100,000
Kraft Nether Rhine Co.	158,600	East German Pig-Iron Syndicate	100,000
Iron Works Meiderich	157,009		
Fried. Krupp	150,211		

All the other allotments are of less than 100,000 tons, the lowest on the list being: Geisweiler Iron Works, 12,000 tons.

The East German Pig-Iron Syndicate only figures with 75,000 tons for 1916 and 1917, while the North German Iron Works in Bremen advanced from 100,000 tons in 1915 to 150,000 for the following two years, etc.

There are numerous special arrangements; the allotment of the Gelsenkirchener concern, the figure for which increases 43,000 tons for 1916 and 1917, only refers to the company's production at the blast furnaces of the Schalker section (Gelsenkirchener and Vulkan-Duisburg), and it does not comprise the same company's production in Luxemburg and Lorraine. The Gelsenkirchen concern, it will be seen, comes second to the aggregate of the two Kraft companies.

There is, perhaps, no more striking example of the German disposition to establish and maintain system and method in the prosecution of commerce, industry, of everything in fact, than their immense structure of kartels and combines, the formation and working of many of which have entailed endless labor and the most patient perseverance.

NOTES AND CORRESPONDENCE

THE KJELDAHL-GUNNING-ARNOLD METHOD FOR NITROGEN

The possibilities—in point of rapidity—of the Kjeldahl-Gunning-Arnold method of determining nitrogen appear not to be fully realized. Trescot[1] and Jensen[2] seem to imply that the digestion should be an hour and a half at least—in some cases two and a half hours. It is to be regretted that they did not try the method out with shorter periods. The following results are presented with a view to inducing experimenters to test the method for short periods of digestion—a quarter of an hour up. The quantity of substances taken in these determinations was 0.7 gram. The periods of digestion—one quarter, one-half, one and a half, and three and a fifth hours—represent the total time that heat was applied. The digestion was very vigorous throughout. The flasks (500 cc. long neck Jena) were set down against full (or almost full) flame of Bunsen burners at the start. The percentages are for nitrogen.

In the case of short periods of digestion (one-fourth to one-half hour), the acid must, of course, be brought quickly to vigorous boiling, in order that the acid vapor may quickly reach

Kjeldahl-Gunning-Arnold Nitrogen Determinations (Percentages)

No.	Periods of digestion	1/4 Hr.	1/2 Hr.	1 1/2 Hrs.	3 Hrs.-23 Min.
5416	Dried blood	14.18	14.28		14.22
		14.12	14.36		14.22
		14.14		14.26	14.24 (3 hrs.)
		14.04			
5417	Calcium cyanamide	16.86	16.90		16.88
		16.88	16.92		16.70
6656	Cottonseed meal		6.12	6.06	
6672	Cottonseed meal		6.64	6.58	
6674	Cottonseed meal		6.12	6.18	
6675	Cottonseed meal		6.56	6.54	
6676	Cottonseed meal		6.12	6.10	
6678	Cottonseed meal		6.76	6.68	
6660	Cottonseed meal		6.08	6.16	
6659	Cottonseed meal and hulls		3.82	3.86	
6655	Shipstuff	2.46		2.44	
6671	Shipstuff		3.04	3.00	
6673	Shipstuff		2.74	2.74	
6662	Red dog	2.30	2.32	2.36	
6661	Peanut bran	3.02	2.96	3.00	
6663	Ground corn and cob	1.52	1.46	1.46	
6657	Ground corn and cob	1.46	1.48		
6669	Corn screenings		1.86	1.94	
6668	Cracked corn		1.50	1.46	
6670	Molasses feed		1.40	1.38	
6658	Wheat bran	2.54		2.56	

the entire nterior of the flask, and bring every particle of substance quickly and completely under the full influence of the reagents. It has fallen to the lot of the writer to make many thousands of nitrogen determinations. He regards a half hour—start to finish—of vigorous boiling as ample for determining organic nitrogen by the Kjeldahl-Gunning-Arnold method. Following the lead—if he remembers correctly—of the late Professor Atwater, he alkalizes, and alkalizes strongly, by adding the sodium hydroxide and potassium sulfide as a mixture. This saves one manipulation and precludes the releasing of hydrogen sulfide. There will be no bumping if a little (50 or so mg.) of No. 80 granulated zinc is added. If a large excess of zinc is added, this, besides being a waste of material, releases so much mercury that some of it (mercury) will be carried over into the distillate, where it manifests itself as minute spheres floating on the surface of the distillate. But the presence of this mercury, never, so far as the writer ever observed, affected the results of the determination.

State Department of Agriculture
Raleigh, N. C., March 12, 1915 J. M. Pickel

[1] This Journal, 5 (1913), 914.
[2] *Ibid.*, 7 (1915), 38.

ON SHORTAGE OF DYES IN THE UNITED STATES

Editor Journal of Industrial and Engineering Chemistry:

In view of the long-maintained complaint of a dyestuff shortage the following based upon the "Monthly Summary of the Foreign Commerce of the United States" published by the Department of Commerce for January 1915 are not without present interest.

Imports for January	1914	1915	Increase	Ratio 1915 to 1914
Alizarin and alizarin dyes	$ 33,400	$ 459,266	$425,866	1375 : 100
Anilin oil	19,872	9,872	—10,000	50 : 100
Anilin dyes	611,350	1,086,570	475,220	178 : 100
Indigo	77,123	183,082	105,959	237 : 100
Totals	$741,745	$1,738,790	$997,045	235 : 100

Imports for the 7 Months Ending Jan.	1913	1914	1915
Alizarin and alizarin dyes	$ 833,715	$ 425,150	$1,222,093
Anilin oil	192,741	131,143	79,320
Anilin dyes	4,230,730	4,199,823	4,278,797
Indigo	680,359	660,493	862,021
Totals	$5,937,545	$5,416,609	$6,442,231

That is, in the seven months ending January, 1915 (during six of which the European War was going on), the imports of coal-tar dyes were $1,025,622 greater than for the corresponding seven months ending January, 1914 and $504,686 greater than the corresponding period ending January, 1913. Or, the 1915 values are 119 per cent of the 1914 values and 109 per cent of the 1913 values.

With the equally insistent complaint of slow business in colored textiles is there not some room for the suspicion that somebody is hoarding dyes? If there be hoarding, *is* there a shortage in the true sense of the word?

90 William Street, New York
March 23, 1915 Bernhard C. Hesse

THE NORMAL CHLORINE CONTENT OF SURFACE WATERS OF WESTERN FLORIDA

Determinations of chlorine in surface waters of western Florida, made by using the Volhard and Mohr methods yielded the following conclusions and results.

A comparison of chlorine determinations in surface waters by the Volhard and Mohr methods showed that 0.01*N* ammonium thiocyanate and the 0.01*N* silver nitrate solutions are too dilute to obtain sharp color changes at the end of the reactions. Careful manipulation with a 0.1*N* solution yields as accurate results as the use of more dilute solutions.

Comparing the Volhard and Mohr methods, using 0.1*N* solutions, the former yielded more satisfactory, concordant and accurate results, although requiring more time.

Many determinations on 24 samples of surface water from Leon County in western Florida, about thirty miles inland from the Gulf of Mexico, showed that they contained from 7 to 24 parts per million of chlorine, the average being 12 parts per million. Rain water in this locality, one determination, was found to contain when concentrated to one-tenth of its volume 0.9 part per million of chlorine, equivalent to 1.4 parts per million of sodium chloride. At the Dry Tortugas[1] the chlorine content is 2.9 parts per million corresponding to 5 parts per million of sodium chloride. A few chlorine determinations on surface waters from Pensacola, on the Gulf, in Escambia County, showed from 21 to 42 parts per million of chlorine.

Chemical Laboratory
Florida State College for Women
Tallahassee, March 1, 1915

C. A. Brautlecht
B. N. Langley

ACTION OF THE NEW ENGLAND DYE COMMITTEE

The New England Section of the Society of Chemical Industry having requested the Northeastern Section of the American Chemical Society to join with them in appointing a committee to consider the manufacture of dyestuffs in the United States, it was voted that the President of the Section be authorized to appoint such a committee.

The representatives of the two sections were as follows:

New England Section S. C. I.		Northeastern Section A. C. S.	
Eugene Barry	F. G. Stantial	John Alden	C. L. Gagnebin
A. A. Claflin	C. A. West	W. B. Nye	Grinnell Jones
W. D. Livermore	S. W. Wilder	W. K. Robbins	J. Russell Marble

On January 29th, at a joint meeting of the New England Section of the Society of Chemical Industry and the Northeastern Section of the American Chemical Society, the Joint Committee on Dyestuffs presented its report through its Chairman, Mr. S. W. Wilder. After a lengthy discussion, Prof. H. P. Talbot offered an amendment to the report which was accepted by the committee, and the following amended report was unanimously passed.

"In the opinion of this committee there is no insuperable chemical or physical obstacle to the establishment of a coal-tar industry in this country, but we believe this is an economic question on which it is outside the provinces of these societies to make a recommendation.

"The subject is one of great importance to the chemical industries of the United States, and should be investigated by Congress.

TO CHANGE THE SPECIFIC GRAVITIES OF SOLUTIONS

Editor of the Journal of Industrial and Engineering Chemistry:

As students are constantly required to alter the specific gravities of solutions for reagent purposes, it would seem that simple arithmetic would be as often applied as the hydrometer, But such is not the case and when the hydrometer is misplaced, trouble very often begins. The following formula will suffice in such a case.

If X = Volume of water (sp. gr. 100) to be added to original solution
S = Specific Gravity of original solution
V = Volume of original solution
S_1 = Specific Gravity of required solution

Then

$$(S \times V) + (X \times 1.00) = (V + X)\,S_1$$

whence,

$$X = \frac{(S - S_1)V}{S_1 - 1}$$

As the quantities S, S_1 and V are known, substitution in the last equation gives the desired information.

U. S. Reclamation Service
San Francisco, January 25, 1915

P. F. Bovard, *Chemist*

PLATINUM THEFT

A professional platinum thief has stolen about $100 worth of platinum from me. He answers the following description: age about 35, prominent nose, peculiar eyes, red hair, freckled face, Boston accent, two large X-Ray burns on his left arm. Height about 5 feet 10 and weight about 180. This note is intended as a warning to other owners of platinum.

Hahnemann Medical College
Philadelphia, March 3, 1915

W. A. Pearson, *Dean*

HYDROMETALLURGICAL APPARATUS—CORRECTION

In my article under the above title, which appeared in This Journal, 7 (1915), 119, the following corrections should be made in addition to those already noted on page 261 of the March issue:

In Table I, page 121, the first heading under "Sand" should be + 100, and not + 200 as given.

Table III, page 124, under remarks in connection with the Porcupine-Crown, Ontario, the figure 83 should read 73 per cent solids.

Page 127—The results of the calculation dealing with the Continuous Counter-Current Decantation flow sheet, Fig. 11, are not quite accurate, owing to the value of "Z" not having been carried out far enough. The results should be:

V = 2.673, W = 1.173, X = 0.298, Y = 0.079, Z = 0.039.

Page 129—The value of Z should be "2.1164 lbs.," instead of "2.7164 lbs.," which means that "2–Solution wasted with the residue, Z, contains 0.1 per cent copper, or 2.1 lbs. per ton of ore."

30 Church Street, New York
March 15, 1915

John V. N. Dorr

PERSONAL NOTES

The 2nd annual meeting of the chemical engineers of the University of Kansas was held on March 12th. The program was as follows: Opening Remarks, by Dean P. F. Walker and Prof. W. A. Whitaker; "The Technology of Clay Refractories," Mr. Paul Teetor, clay investigator, University of Kansas; "Rock Salt Mining in Kansas," Mr. Sam. Ainsworth, mining engineer, Lyons, Kansas; "Chemical Process Control," Mr. William J. Kee, Jr., supt., National Zinc Co., Kansas City, Kansas; "The Chemist in Commerce," Mr. Rudolph Hirsch, chemist, Ridenour-Baker Co., Kansas City, Missouri; "Manufacture of Portland Cement," Mr. Chris Goll, chemist, Bonner Portland Cement Co., Bonner Springs, Kansas; "The City Milk Problem," Mrs. George H. Hoxie, Consumers League, Kansas City, Missouri, Mrs. Joseph W. Murray, former food analyst, State Laboratories, Dr. F. H. Billings, prof. of bacteriology and Dr. E. W. Burgess, assistant professor of sociology, University of Kansas. In the evening a "chemical smoker" was given in Eagles' Hall.

Prof. R. W. Thatcher, chief of the division of agricultural chemistry of the University of Minnesota, has been elected president of the Minnesota Section of the A. C. S. The section will hereafter hold regular meetings on the third Friday evening of each month at various laboratories in the Twin Cities.

[1] U. S. Geol. Survey, *Bull.* 319.

Dr. A. F. Gilman, head of the chemistry department of Ripon College, has returned for the second semester's work after a half year's leave of absence spent in study and travel.

The U. S. Civil Service Commission announces an examination for assistant in agricultural geography, for men only, to fill a vacancy in this position in the Office of Farm Management, Bureau of Plant Industry, Department of Agriculture, Washington, D. C., at a salary ranging from $1,800 to $2,000 a year. The duties of this position will be to assist in investigations being carried on in the above office concerning the development of agricultural enterprises under the influence of geographic conditions, such as topography, climate, soil, location, etc.

Mr. John W. Hornsey, who has been located, for the past two and one-half years, at Trona, Cal., engaged in the development of a method for the separation of potash, borax and soda from the Searles Lake salt deposits, will return to New York at an early date and resume his practice as a consulting chemical engineer, with temporary headquarters at the Chemists' Club.

Mr. Arthur G. Weigel, a graduate assistant in chemistry at the Massachusetts Agricultural College, has accepted a position as chemist in the Experiment Station at Stillwater, Oklahoma.

Dr. Horace Grove Deming, for the past three years associate professor of chemistry in the Philippine College of Agriculture has been appointed professor of chemistry and chief of the department in the University of the Philippines. This is to fill the vacancy occasioned by the death of Dr. Paul Caspar Freer.

The Washington Academy of Sciences will give a series of five illustrated public lectures during March and April. Among these was an address, April 1st, on "High Explosives and Their Effects," by Prof. Charles E. Munroe, of George Washington University.

The subject for the April meeting of the Cincinnati Section of the A. C. S. is "The Manufacture of Soaps and Glycerine."

A factory for the extraction of radium is being erected at Balloch, in the western part of Scotland. The enterprise is under the control of Mr. J. S. MacArthur.

The Rochester Section of the A. C. S. has just issued a booklet which contains a new directory of its members and a programme of its meetings.

The Northern Chemical Engineering Laboratories, of Madison, Wisconsin, announce the adoption of the shorter name "C. F. Burgess Laboratories." The new name implies no change in management or ownership.

The W. Beckers Aniline & Chemical Works of Brooklyn, N. Y., have purchased, in the outskirts of Brooklyn, a tract of about 15 acres bounded by East 83rd, East 84th and East 85th Sts., Ditmas Ave. and the New York Connecting Railroad, where a large-sized chemical plant, consisting of 23 separate buildings, will be erected. Last November the old plant of this concern was destroyed to a large extent by fire, followed by several explosions, killing two chemists and injuring 36 workmen. Three buildings of the new plant are finished, the railroad siding is being laid and the foundations for the boiler house and chimney have just been started.

The department of chemistry of the College of the City of New York announces the following public lectures during the Spring semester, 1915: *March 19th*—"White Lead: Its Manufacture and Use," Dr. G. W. Thompson, chief chemist of the National Lead Co. *March 25th*—"Glass and Its Manufacture," Prof. Alexander Silverman, director of the department of chemistry, University of Pittsburgh. *April 16th*—"Vitamine—A New Food Principle," Dr. F. E. Breithut, of the department of chemistry, College City of New York. *May 7th*—"Crystal Growth and Other Educational Subjects," Mr. Seldon G. Warner, expert in the Edison laboratories.

The Rochester Section of the A. C. S. met on March 15th in conjunction with the Rochester Electroplaters' Society; electroplating problems from the standpoint of the electroplater and the chemist were discussed.

The March meeting of the New York Section of the American Electrochemical Society was held on March 12th in joint session with the New York Section of the American Institute of Electrical Engineers. The electrochemists were represented on the program by Frank B. Washburn, who spoke on "The Cyanamid Process." The electrical engineers were represented by Leland L. Summers, whose subject was the "Fixation of Atmospheric Nitrogen."

The following papers will constitute the program for the April 9th meeting of the New York Section of the A. C. S.: "Contribution to the Structure of Primary and Secondary *p*-Aminophenylmercuric Compounds," by Walter A. Jacobs and Michael Heidelberger, of the Rockefeller Institute for Medical Research; "A New Test for Copper," by W. G. Lyle, L. J. Curtman and J. T. W. Marshall, of the College of the City of New York; "Refining Vegetable Oils," by Chas. Baskerville, of the College of the City of New York; "A Rational Process of Fractional Distillation," by M. A. Rosanoff, Mellon Institute of Industrial Research, Pittsburgh.

The 22nd annual convention of the National Fertilizer Association will be held at The Homestead, Hot Springs, Va., July 13 and 14, 1915. It is altogether probable that the Southern Fertilizer Association will hold their annual meeting on Monday, July 12th, at the same place. The Middle West Soil Improvement Committee of the National Fertilizer Association will meet at the same place on July 16th and 17th. With July 15th devoted to special committee meetings and the National Association golf tournament, practically the entire week at The Homestead, Hot Springs, will be of interest to the fertilizer manufacturers and the allied trades.

Dr. Pierre de P. Ricketts announces the dissolution of the firm of Ricketts & Banks by mutual consent on March 1st. Dr. Ricketts will continue his practice as a consulting chemical and metallurgical engineer, under the name of Ricketts & Company, with offices and laboratories at 80 Maiden Lane. The new business will be continued on a coöperative basis with departments for industrial research, general analytical work and metallurgical engineering.

The Pittsburgh Section of the A. C. S. met on March 18th in the new building of the Mellon Institute, University of Pittsburgh. Prof. M. A. Rosanoff, of the Mellon Institute, addressed the meeting on "A Rational Process of Fractional Distillation." The Section were the guests of the Institute, and following Dr. Rosanoff's lecture the new building was inspected, and a social evening and "smoker" were enjoyed.

Edwin F. Hicks, chief chemist, Victor Talking Machine Co., Camden, N. J., spoke on the "Responsibilities of the Analytical Chemist," at the meeting of the Chemical Society of Drexel Institute on March 2nd.

On March 19th, Professor A. H. Gill addressed the Detroit Engineering Society on "Lubricating Oils: Essentials and Characteristics."

The 7th semi-annual Meeting of the American Institute of Chemical Engineers will be held in San Francisco, August 25th to 28th. An itinerary is being arranged so that the natural scenery of the west may be seen and also some of the more important mining operations as well as the typical chemical industries of California.

The department of chemistry of the Iowa State College, Ames, Iowa, is now installed in the new building which replaces the one destroyed by fire in March, 1913. The initial cost of the new building was $200,000. It covers a space 244 ft. x 162 ft., is three stories high, has a usable basement, is constructed entirely of brick, stone and concrete and is as nearly fireproof as possible.

GOVERNMENT PUBLICATIONS

By R. S. McBride, Bureau of Standards, Washington

NOTICE—Publications for which price is indicated can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. Other publications can usually be supplied from the Bureau or Department from which they originate. Consular Reports are received by all large libraries and may be consulted there, or single numbers can be secured by application to the Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington. The regular subscription rate for these Consular Reports mailed daily is $2.50 per year, payable in advance, to the Superintendent of Documents.

DEPARTMENT OF AGRICULTURE

Utilization of the Fish Waste of the Pacific Coast for the Manufacture of Fertilizer. J. W. Turrentine. Department Bulletin 150, from the Bureau of Soils. 71 pp. Paper, 15 cents. This bulletin discusses the utilization of the waste, particularly of the salmon canning industry, indicating the commercial conditions to a sufficient extent to make clear the source, character, methods of disposal, and amount of the waste. Analyses are given of the materials available not only from the salmon industry but also from the other similar packing industries, and there is included an estimate of the cost of installing and operating a plant for this work. The use of fish scrap with kelp to produce a mixed fertilizer is also discussed.

Cactus Solution as an Adhesive in Arsenical Sprays for Insects. M. M. High. Department Bulletin 160, from the Bureau of Entomology. 20 pp. Paper, 5 cents. This bulletin describes the use of cactus solution with the various kinds of arsenic-containing spray solutions and indicates the various preservatives which can be used to prevent decomposition of the cactus extract. A considerable number of analyses of cactus plant ash and extract are given.

A Field Test for Lime-Sulfur Dipping Baths. Robert M. Chapin. Department Bulletin 163, from the Bureau of Animal Industry. 7 pp. Paper, 5 cents. This bulletin describes a portable testing outfit for estimating the strength of lime-sulfur baths used in the dipping of sheep and includes tables indicating the proper change in the bath to restore to normal concentration.

Field Test with a Toxic Soil Constituent: Vanillin. J. J. Skinner. Department Bulletin 164, from the Bureau of Soils. 9 pp. Paper, 5 cents. The effect upon plant growth of vanillin is demonstrated by pot and field tests.

Ability of Colon Bacilli to Survive Pasteurization. S. Henry Ayers and W. T. Johnson, Jr. Journal of Agricultural Research, 3 (1915), 401–10.

Organic Phosphoric Acid of Rice. Alice R. Thompson. Journal of Agricultural Research, 3 (1915), 425–30.

PUBLIC HEALTH SERVICE

Purity and Strength of Household Remedies, Variations in Purity and Strength of Widely Used Drugs and Preparations; a Possible Source of Danger to the Patient. Martin I. Wilbert. Public Health Reports, January 29th. Also obtainable as a reprint.

The Limitations to Self-Medication. Martin I. Wilbert. Public Health Reports, 30, 470–73. Also obtainable as a reprint. The uses and abuses of proprietary preparations and household remedies are discussed with suggestions as to what drugs form acceptable remedies and what are objectionable in self-medication.

Hypochlorite Treatment of Water Supplies. H. A. Whittaker. Public Health Reports, 30, 608–18 (February 26). Also available as a reprint. This article describes a portable plant and field equipment for its administration in caring for water supplies in time of emergencies and epidemic.

HYGIENIC LABORATORY

Examination of Drinking Water on Railroad Trains. Richard H. Creel. Part 2 of Bulletin 100. 72 pp. Paper, 10 cents.

BUREAU OF MINES

Metallurgical Smoke. Charles H. Fulton. Bulletin 84. 90 pp. Paper, 20 cents. This bulletin describes the commercial methods utilized in prevention of smoke and fume nuisances in various classes of metallurgical work. The general aspects of the smoke problem are discussed both from the standpoint of vegetation and public health and the standpoint of economy in plant operation. The character of smoke and fume from different processes is pointed out and the methods and machinery used for elimination or retention of the fume are described in detail. The bulletin is a general review of the subject, not on a report of the experimental work.

GEOLOGICAL SURVEY

The Calcite Marble and Dolomite of Eastern Vermont. T. N. Dale. Bulletin 589. 67 pp. "The object of this bulletin is twofold—to locate definitely and describe accurately the marbles and dolomites of eastern Vermont with a view to setting forth their possible economic uses and to discuss whatever features of scientific interest they may present." The deposits are described in considerable detail by locations which include the most productive regions contributing to the marble industry of the United States.

Structure of Fort Smith-Poteau Gas Field, Arkansas-Oklahoma; Glenn Oil and Gas Pool and Vicinity, Oklahoma. Carl D. Smith. Bulletin 541-B. 25 pp. and two maps.

Deschutes River, Oregon, and Its Utilization. Several articles by F. M. Henshaw, J. H. Lewis, E. J. McCaustland and Others. Water Supply Paper 344. 200 pp. and 38 maps. Paper, 50 cents. Prepared in coöperation with the State officials of Oregon.

DEPARTMENT OF COMMERCE

List of Publications. The 11th edition of the list of publications of the Department of Commerce which are available for distribution is dated January 1, 1915. 73 pp. Free.

BUREAU OF FOREIGN AND DOMESTIC COMMERCE

Pineapple Canning Industry of the World. J. Alexis Shriver. Special Agents, Series 91. 43 pp. Paper, 5 cents. This publication incorporates the results of an investigation of all the pineapple-canning centers of the world, with special emphasis on superiority of Hawaiian methods over those of older pineapple districts of the Far East.

COMMERCE REPORTS—FEBRUARY, 1915

Special Supplements issued in February include: Persia 57*a* and Honduras 31*a*.

The present status of the **beer, porcelain and dye industry** in Japan are discussed. (P. 450.)

Plans are being made to increase the **soap industry** of Manchuria, using **soya-bean oil.** (P. 452.)

The regulations regarding **monazite mining** in Brazil are stated. (P. 475.)

Mr. Thomas H. Norton, formerly U. S. Consul at Chemnitz, Germany, is engaged in a special investigation for the Department of Commerce, of the **chemical and dyestuff industries** in the United States. (P. 490.)

A summary is given of the **mineral production** of the world for 1912, as published in the British Mines and Quarries Report. (P. 498.)

The German Potash Syndicate is selecting a means to "denature" **potash salts,** *i. e.*, prevent their use for ammunition or military purposes while permitting their use as **fertilizers.**

The **gold mining** industry of the Philippines is flourishing. (P. 530.)

Camphor is now being obtained in the Philippines from a shrub "Blumea balsamifera." (P. 589.)

The German **paper industry** has been very seriously crippled, owing to a shortage in raw materials, previously imported. (P. 613.)

In Italy the oil obtained from tomato seeds is used for **soap,** and is also said to be edible. (P. 615.)

The supply of Turkish **gum tragacanth** is very short, owing to scarcity of labor to gather it. (P. 625.)

A special licensing committee exists in England to regulate shipments of **rubber** to the United States. (P. 633.)

The **iodine** production of Chili is restricted by a controlling organization. The normal output could be doubled if desired. (P. 644.)

A market for **infusorial earth** is desired by Chili. (P. 647.)

The **bergamot-oil** industry of Catania, Italy, is described. (P. 652.)

The **tin plate** industry of Wales has suffered not only because of reduced market but also on account of the increased cost of tin. (P. 660.)

Japan is now supplying China and India with **sheet glass** formerly imported from Belgium. (P. 663.)

Various provinces in China are purchasing **smokeless powder** from American firms. (P. 677.)

The details of the scheme of the British Government for fostering the **dyestuff** industry have been materially changed, with special reference to the needs of the users of dyes. A stock company with a capital of £1,000,000 is to be established to which the Government will loan an equal amount for 25 years at 4 per cent. In addition the Government will grant £100,000 per year for 10 years for research work. (P. 678.)

The **sulfur** output of Hokkaido, Japan, is increasing, due partly to difficulty in securing Italian sulfur for America. (P. 687.)

The United States import statistics for **fertilizer materials** include the following articles: Kainite, potassium chloride, potassium sulfate, "manure salts," sodium nitrate, ammonium sulfate, bone dust, guano, apatite, calcium cyanide, crude phosphates, and basic slag. (P. 694.)

British **oil mills** are increasing their demand for Philippine **copra.** (P. 702.)

A company with a capital of £5,000,000 is being organized in Russia to develop the **dyestuff industry.** (P. 729.)

The exportation from Germany of **kainite** containing less than 20 per cent of potash, is now permitted. (P. 737.)

The Chinese people are urged to plant the **indigo** plant wherever the poppy has been previously grown. (P. 784.)

A preliminary report on the **dyestuff** situation in the United States submitted to the United States Senate by the Secretary of Commerce, after analyzing the conditions, suggests the need of "anti dumping" legislation to prevent unfair foreign competition. (Pp. 786–9.)

A company in India has just erected plants for the manufacture of **cement** by the wet process in rotary kilns, and also of tile, fire brick, drainage pipes and other **clay products.** (P. 804.)

STATISTICS AND INFORMATION REGARDING EXPORTS FROM VARIOUS LOCALITIES IN THE UNITED STATES

PHILIPPINES—441
Copra

BRAZIL—453
Rubber

MEXICO—489
Crude oil

CHINA—519
Antimony

PERSIA—Sup. 57a
Gums

PARIS—701
Hides
Soap
Wines

PORTUGAL—750
Argols
Cork
Hides
Rubber
Sulfur ore (pyrite?)
Wolframite

GERMANY—626
Dextrin
Thorium nitrate
Glue
Enamel ware
Chinaware
Dyestuffs
Fats
Oils
Linoleum
Arsenic
Sugar-beet seed
Paints
Platinum
Zinc dust
Potash
Bronze powder
Tungsten

HONGKONG—664
Tin

DENMARK—682
Casein
Chemicals
Dextrin
Flint pebbles
Glycerine
Hides
Safety matches
Condensed milk
Pottery
Rags
Rennet
Scrap rubber
Soya bean oil

HONDURAS—Sup. 31a
Hides
Rubber
Sarsaparilla

RECENT DEMANDS FOR AMERICAN GOODS ON ACCOUNT OF THE WAR CONDITIONS

FRENCH WEST INDIES—455
Chinaware
Earthenware
Glassware
Fertilizers
Ammonium salts

ECUADOR—561–586
Soap
Hides

ITALY—598
Starch
Brandy
Cottonseed oil
Leather
Glycerine
Zinc

Benzine
Gasoline
Lubricating oils
Paraffin
Dyestuffs
Bronze
Caustic soda
Chemicals
Fertilizers
White zinc
White lead
Steel plate
Tallow
Tin
Copper

GERMANY—705
Phosphate rock

COSTA RICA—508
Portland cement in steel drums

PERSIA—Sup. 57a
Petroleum
Sugar
Rubber goods
Matches
Paints
Dyes
Soap
Candles
Paper
Glassware
Galvanized iron
Enameled ware

The **soya-bean** industry of Manchuria has been hampered by lack of transportation. (P. 809.)

The plant is to be erected in Yucatan to make **paper pulp** from "henequen" (a variety of sisal) stalks and waste. (P. 814.)

BUREAU OF STANDARDS

Regulation of Electrotyping Solutions. Circular 52. 13 pp. This is the first printed edition of this circular; see announcement of preliminary edition, THIS JOURNAL, 6 (1914), 1043.

A Wheatstone Bridge for Resistance Thermometry. C. W. WAIDNER, H. C. DICKINSON, E. F. MUELLER AND D. R. HARPER, 3d. Scientific Paper 241. 20 pp. "The Wheatstone bridge described in this paper was designed with special reference for flexibility of use in measurements with resistance thermometers. The bridge is adapted to use with either the Siemens type or Callender type of resistance thermometer, or with the potential terminal type of thermometer by the use of the Thomson double-bridge method. The instrument is also arranged so that it may be completely self-calibrated.

The accuracy attainable with the bridge is such that resistances of 1 ohm or more can be measured to an accuracy of 1 part in 300,000 in terms of the unit in which the calibration is expressed. This corresponds to an accuracy of about 0.001° for measurements with the platinum resistance thermometer."

BOOK REVIEWS

Coal Gas Residuals. By Frederick H. Wagner, M.E. New York: McGraw Hill Book Co. 1914. xi + 179 pp., with diagrams. Price, $2.00.

The title of this book would indicate a rather general survey of the nature of the residuals secured in gas manufacture, or perhaps the various methods of obtaining same, but the reader does not progress far before he finds that in reality the book aims to set forth primarily the process invented by the late Walther Feld of Lin-am-Rhein. To be more descriptive of the contents, the title might better read "Coal Gas Residuals by the Feld Process." The theories of this process are so very interesting by themselves and so revolutionary, if the dreams of the talented inventor could all be realized, as to deserve by themselves a book even more ample than the present.

In the introductory chapter is given a brief survey and in the later chapters a more detailed description of the ambitious plan of the complete Feld system, which aims to take the coal gas directly from the gas retorts or coke ovens and pass it continuously through a series of eleven Feld centrifugal spray washers of an interesting and very effective design, in which the gas is successively freed from Pitch, Heavy, Middle and Light Oils, Ammonia, Sulfur, Cyanogen, Naphthalene and Benzol, and all of these products are recovered in merchantable form. The gas engineer naturally opens his eyes on being assured that instead of recovering coal tar more or less contaminated with ammoniacal liquor, which tar must later be worked up in a separate distillation process, he is to draw pitch continuously from one washer and as many and such fractions of tar oil from succeeding washers as he desires. Still further he pricks up his ears when he reads on page 31, as a presumably typical example, that instead of selling tar at $5.00 per ton, the Feld washers whizzed this ton of tar into products sold for $16.00. And when later in the book it is set forth how comparatively simple it is to recover, direct from the gas, sulfur for use in converting Ammonia into Ammonium Sulfate without the outside purchase of expensive Sulfuric Acid, and the enormous returns to be secured from Benzol, etc., the gas engineer sees gold dollars of profit shining even more brilliantly than the famous coal tar colors and inquires how long he has been asleep, why he has not been awakened earlier, and where he can go to see all this in working order.

The gas engineer, however, is naturally thorough and sets to work to analyze the plan and figures, and he finds that as yet the complete process is a very ingenious and attractive theory, of which so far only certain parts have been imperfectly worked out in practice. He finds further that the Feld patented centrifugal washer is a very effective piece of apparatus and that *if* he can deliver his crude gas to the washers under reasonably uniform conditions of quantity, temperature, pressure and composition, the theory may perhaps be worked out in practice to a considerable extent. But he finds, also, that if it could be worked out in practice, the mere fractional condensation of tar into pitch and oils does not and never did turn $5.00 into $16.00, nor anything like it. This statement as to values is absolutely misleading and since it stands out so prominently as indicating what may be expected, the author should have been more careful to get the facts. We have no doubt that here, as in many other places, he was copying from European reports of Feld without knowing sufficiently about the tar industry to appreciate how gross was such error and how it throws in doubt his other claims.

We used above the important word "if" to indicate that there is considerable doubt in the minds of many whether the necessary uniform conditions can be secured in practice. The reader must keep in mind that this process is not like the continuous fractional condensation of a uniform gas or vapor from a single source, but that he is dealing with the gas from perhaps seventy-five or more large coke ovens, or an even greater number of small gas retorts in different stages of carbonization and consequently giving off different gases. Theoretically, perhaps, suitable rotation in operation will be secured so that at all times there is a certain average condition, but this will not be found by any means easy to practice. We should hesitate greatly before saying that it cannot be worked out in practice, and we expect to see excellent progress along these lines, but in the few plants (mostly in Germany) which have tried the Feld process there has been small promise that all of the condensation products will be secured in merchantable condition direct from the centrifugal washers, as the book would have us expect.

There seems more reason to expect success in working with Ammonia and Cyanogen than with the coal tar, for the reason that in the former cases we are dealing with definite chemical compounds which, though elusive, have certain fixed characteristics, whereas tar consists of perhaps over one hundred and fifty distinct and different chemical substances, all mixed together in varying forms and proportions, depending on the coal being carbonized, the temperature and stage of carbonization, the shape and size of the retort and the length of travel of the gases while exposed to relatively high heat either in the retorts or ovens or mains leading to the washers. Reports from some of the European experiments show what may be expected from the complex conditions; instead of securing uniform pitch of a given melting point, the product from the pitch washer would be pitch at one moment, thin tar at another, constantly fluctuating, so that instead of securing merchantable pitch and oil products, they secured, in fact, in some cases, products less merchantable even than the ordinary tar, because less uniform. There seems little reasonable expectation of securing by direct condensation pitch of sufficiently uniform consistency and of the grade and quality required to meet American conditions, as these are far more complex and much further developed than is the pitch business in Germany, notwithstanding the well-known German superiority in the chemical end of the coal tar industry.

Without attempting to go into detail, the book contains many statements and tabulations of figures which the author should be sure are checked carefully before another edition. We comment on one or two inaccuracies.

On page 8 is an obviously incorrect statement that the "free carbon" in coal gas tar contains "about 85 per cent volatile matter of an oily, rather heavy nature." The percentage would hardly ever exceed 10 per cent.

On page 29 it is stated that at a plant in Upper Silesia they obtained 5500 lbs. of thin soft pitch from a Feld plant handling the gas from 395 tons of coal in twenty-four hours. This Silesian coal would probably average a yield of at least 3 per cent of tar, equaling at least 23,700 lbs. of tar in twenty-four hours, and such tar would contain at least 14,000 lbs. of soft pitch. There is a little discrepancy between this quantity and the 5500 lbs. reported recovered.

Also on page 32 in Table VIII is included "Carbon Content (Anyline, Pyridine, Methane) 0.23 and 0.32 percent." "Anyline" should evidently read "Aniline," and even with this correction the item would not be intelligible to a gas engineer, who might easily suppose that Aniline, Pyridine and Methane were the carbon compounds and the only ones secured, whereas we interpret it to indicate the percentage of the so-called "Free Carbon" in the tar obtained by washing the same with Aniline and Pyridine by the Kramer Spilker extraction method.

At the end of the chapter on Naphthalene (page 42) reference is made to a possible source of revenue to the gas producer from the sale of Naphthalene as a fuel for internal combustion engines. The authority apparently overlooked the fact that this possible outlet in Europe is not likely to materialize in the United States which is blessed with large supplies of comparatively cheaper and much more convenient petroleum oils.

In this review especial attention has been given to the tar end of the Feld process, as this is the greatest departure from existing methods and other new processes being developed, but there is much to be worked out yet in the other operations of the system before they will be seriously considered, even by themselves, for American conditions of gas and coke industries. It is to be noticed that in the chapter on Ammonia and Benzole the author outlines more fully a number of the other processes besides that of Feld. Also in the appendix are given a number of useful tables. It is to be regretted that in Table XXX many items are missing which should, if available, be included later to make this complete.

In conclusion, it is to be hoped that the excellent inventive work of Feld will not be brought to an abrupt close by his untimely death. It may be that later one of his co-workers, Jahl and the author of this book, will be able to develop many parts of the theory into workable practice within the limits reasonably obtainable. R. P. PERRY

The Preservation of Structural Timber. By HOWARD F. WEISS, Director, Forest Products Laboratory, U. S. Forest Service. New York: McGraw-Hill Book Co., 1915 viii + 312 pp., with illus. Price, $3.00 net.

All who are interested in the preservation of timber will welcome Mr. Weiss' book as one peculiarly adapted as a volume of reference to the subject of which it treats. It is largely a compilation of the various circulars and bulletins issued by the U. S. Forest Service and other government bureaus during the last eight years, supplemented with extracts from the proceedings of such widely known organizations as the American Wood Preservers' Association and the American Railway Engineering Association. It will prove a great convenience to all who need to refer frequently to these scattered publications.

The contents of the book are well indicated by the chapter headings. Chapter I, an Introduction to the Subject, defines wood preservation, its importance, the present state of the industry in the United States, and its effects on the conservation of our timber, with something as to the history of the subject.

Chapter II, Factors which Cause the Deterioration of Structural Timber, describes their relative importance, decay insects, mechanical abrasion, fire, soil characteristics and birds.

Chapter III, The Effect of the Structure of Wood upon Its Injection with Preservatives.

Chapter IV, The Preparation of Timber for Its Preservative Treatment, referring to the season of cutting and to the seasoning of timber by various methods.

Chapter V, Processes Used in Protecting Wood from Decay—The author does not seem to be aware of the fact that the Creo-Resinate Process of wood block treatment has practically been abandoned, or that the Vulcanizing Process of the Old New York Vulcanizing Company is in a similar state.

Chapter VI, Preservatives Used in Protecting Wood from Decay—Here the author does not indicate with sufficient clearness the fact that coke-oven tars and water-gas tars are used for this purpose rather than distillates from the same. He writes of water-gas tar creosote and states that it is seldom sold under its own name. While this may be true of distillates from this tar it is quite the reverse with the tar itself as sold for timber treatment, in regard to which he seems to be uninformed. The Specifications of the National Electric Light Association, which he quotes, are not for water-gas tar creosote but for the water-gas tar itself. There are now in use in the Unites States approximately 500,000 square yards of wood paving blocks treated with this material, and some of this work is seven years old, the results being entirely satisfactory. No mention is made of the Otto Hoffman coke-oven tar distillates which are now upon the market.

Chapter VII, The Construction and Operation of Wood Preserving Plants, is worthy of commendation. It is thorough and accurate and shows that the author is well versed in the requirements of a first-class plant and the methods of its operation. A section of this chapter on the Inspection of Treatments, is particularly fair and intelligent and worthy of consideration by many engineers and inspectors who are all too frequently inclined to be unreasonable in their demands.

Chapters VIII to XV refer to the Prolonging of the Life of Ties, Poles and Cross Arms, Fence Posts, Piling and Boats, the Life of Mine Timber, the Life of Paving Blocks, Shingles and Lumber and Logs.

In the chapter on Prolonging the Life of Paving Blocks the author fails to refer to the use of coke-oven tar as a preservative, nor does he realize that most of the bleeding of blocks under the hot summer sun, to which he refers, is due to the use of such a preservative.

Chapter XVI treats of the Protection of Timber from Fire, and Fire-proofing wood, together with the effect of cresote on its inflammability.

Chapter XVII, The Protection of Wood from Minor Destructive Agents, includes the effects of alkaline soils, birds, sap stain and sand storms.

Chapter XVIII, The Strength and Electrolysis of Treated Timber, refers to the effect of preservatives and the temperature and pressure at which they are applied, upon the strength of the wood, and to the electrical resistance of wood treated with creosote and zinc chloride.

Chapter XIX, The Use of Substitutes for Treated Timber, refers to the use of concrete for this purpose, and the replacing of wood by steel, masonry and concrete for many structural purposes, as in bridges and steel cars.

Chapter XX, Appendices, considers minor wood preserving processes and patented and proprietary preservatives used in the United States, methods of analysis of preservatives and U. S. patents. In the methods of analysis of creosote he fails to give any for determining the presence of acetic acid or acetates, although some specifications still require that the oil shall be free from them.

The list of U. S. patents on wood preservation is extensive and forms a valuable feature of the book.

As a whole, the book fills a field which has not hitherto been covered satisfactorily and it should and will, no doubt, have a wide circulation. CLIFFORD RICHARDSON

Metallurgy: A Condensed Treatise for the Use of College Students and Any Desiring a General Knowledge of the Subject. By HENRY WYSOR, B.S., Prof. of Metallurgy in Lafayette College. Second Edition. The Chemical Publishing Co., Easton, Pa., 1914. Price, $3.00.

The first edition was reviewed in THIS JOURNAL, 1 (1909), 49. The book has now been enlarged from 308 to 391 pages, following the same scheme of treatment as the first edition. The first seven chapters of 100 pages deal with the introduction to metallurgy such as the physical properties of metals, fluxes and refractories, combustion, fuels, ore dressing, furnaces and accessory apparatus. Iron and steel are dealt with in 125 pages, the section on electrolytic processes being new. Copper, 42 pages; Lead, 24 pages; Zinc, Tin and Mercury, 15 pages; Silver and Gold, 33 pages; Nickel, Aluminium, etc., 11 pages; Alloys, etc., 20 pages. Prof. Wysor has undertaken to bring the whole field of metallurgy within this small compass and has done it well, producing a well balanced book.

Some of the mistakes have been changed, but many remain, *e. g.*, Silicon in iron, p. 107; the ideas expressed are vague. We know that two and only two compounds form, Fe_2Si and FeSi. On p. 269, "small percentages of silver lower the melting point of lead and large quantities harden it and raise the melting point." This shows a haziness in the understanding of the difference between melting and freezing points, for silver lowers the melting point of lead to the eutectic temperature and never raises it; p. 288, "silver alloys with zinc more readily than it does with lead; therefore if zinc is melted with lead and silver the zinc upon separating carries most of the silver with it." Again the old and vague ideas are expressed. Modern work on alloys shows that the reason lies in the fact that lead and zinc form two conjugate solutions, whose "partition" coefficient for silver is so great that most of the silver is found in the zinc.

Taken as a whole, the book is to be commended in that it gives us a clear and concise account of the general principles of the metallurgy of the different metals.

The chief criticism to be made is in the section on alloys, Chapter XXIX. This ought to be rewritten and placed after the physical properties of metals at the beginning of the book.

Minor criticisms such as follow are due to the retention of the old ideas, for example "affinity," used both for solubility and for heat of combination. On p. 6 we read, "Some metals, having practically no alloying affinity will, upon cooling from a fused mixture separate more or less completely, into layers according to their specific gravities. This is called liquation and is the opposite of diffusion." On p. 18, Fluxes, "Some substance of the opposite chemical character to the gangue is added and combination ensues with the formation of an easily fusible compound. The substance added is called a flux and the resulting compound is slag." The work of Vogt and of the Geo-Physical Laboratory has upset all our old ideas on the subject of slags by showing us that they are solutions like alloys and behave as such. Most slags owe their easy fusibility to the presence of a eutectic. Page 105, "Iron may be made to dissolve as much as 4.63 per cent of its own weight of carbon." The work of Wittorf shows us that solubility is a function of temperature and alloys beyond Fe_3C (6.67 per cent carbon) are readily formed when the requisite temperature is reached.

In the chapter on wrought iron the long description and illustrations of the Catalan forge and bloomary might be replaced by an account of the charcoal hearth.

W. Campbell

The Manufacture of Organic Dyestuffs. By André Wahl, D.Sc. Translated by F. W. Atack and published by G. Bell & Sons, London, 1914. Size, $7^1/_2 \times 5$. Price, $1.60 net.

This book is a translation of Dr. Wahl's "L'industrie des matières colorantes organiques," which was published as one of a numerous series of volumes of Derômes Bibliotheque des industries chimiques. It is somewhat of the general nature of Benedickt's "Chemistry of the Coal Tar Colors" but as this has now gone out of print and also is rather behind the times in its information, the present volume is a very acceptable contribution to the literature. One feature to be recommended is that it does not take up valuable space in educating the reader in general organic chemistry but goes right at the subject of the coal tar dyestuffs with the supposition that the reader will be sufficiently prepared in organic chemistry to understand the chemical problems with which the book deals. Again, the application of the dyestuffs, that is to say, the practical use of the products in the dyeing of various materials, is not gone into in any detail but is only slightly touched upon, it being considered beyond the scope of the volume; and this is well, for much better information on the application of the dyes can be obtained from other books having this object more in view.

In the first part, this volume takes up the consideration of the raw materials, describing briefly coal tar and the various derivatives to be obtained from it by processes of distillation. This part of the book, however, is too brief to be of any special value and it would have been well if the author had given us more information concerning the preparation of this raw material with the object of the manufacture of dyestuffs in view. The second part of the book deals with the chemical properties and methods of preparation of the so-called intermediate products and describes in some detail the general reactions whereby these intermediate products are made. This includes such reactions as sulfonation, alkaline fusion, nitration, reduction and alkylation. The third part deals with the organic dyestuffs themselves, classified under the generally recognized chemical groups. In this portion of the book a good deal of the general dyestuff chemistry is discussed and a few examples of the manufacture of specific dyes are given.

The book is primarily a text-book for students and can hardly be considered as a book for the study of the practical methods of manufacturing dyes. At the present time, when there is a good deal of interest in this country concerning the possible enlargement of our dyestuff industry, there must be many who are sufficiently interested in the subject to become more familiar with the chemistry of the processes whereby dyestuffs are made, and to them this book will be of considerable value. In my opinion, however, it does not measure up to the same standard as that found in a similar book by Seyewitz and Sisley on the "Chemistry of the Organic Coloring Matters," nor does it have the same scope and detail as Bucherer's "Lehrbuch der Farbenchemie," which has appeared almost simultaneously, but unfortunately it is not as yet available to the American reader in an English translation. However, Atack's translation is a very good one and under the present circumstances is a welcome addition to our rather limited literature in English on this subject.

J. Merritt Matthews

The Hydrogenation of Oils. By Carleton Ellis, S.B. New York: D. Van Nostrand Company. 1914. 145 illustrations. x + 340 pp. 8vo. Price, $4.00.

In this work, the author has presented a review of this new and interesting development of the chemistry of fats so far as that industry has been reported and discussed in publications. The literature of the subject is well presented and it would seem from an examination of the work as though very little of what has ever been written on this subject either in journal publications or in patent records had been omitted.

The different processes are presented to the reader very much as the inventors of the processes themselves describe them and the claims of each worker in this field are fully set forth.

A criticism to which this treatise is fairly subject is that it is lacking in perspective, that is, that the important and the relatively unimportant points are presented to the reader upon a common plane as though they were features of equal magnitude. This, however, is evidently the author's intention, for he states in the preface that he did not think it practicable to carry through a vein of critical comment "at this stage of a young art," and that all he aimed to accomplish was to "array the multitude of processes, formulae proposals and opinions, leaving to the reader the selection of that which should prove of greatest utility."

The work regarded as a review of the literature appears to be excellent; as a guide to direct the reader toward the practical and away from the purely theoretical, it makes no pretenses but since it is the first book of its kind and has the great merit of completeness, it should prove a valuable addition to the library of the modern chemist.

Parker C. McIlhiney

NEW PUBLICATIONS

By John F. Norton, Massachusetts Institute of Technology, Boston

Acetylene: Oxy-acetylene Welding and Cutting: including the Operation and Care of Acetylene Generating Plants: and the Oxygen Process for Removal of Carbon. By C. F. Swingle. 16mo. 190 pp. Price, $1.00. Drake, Chicago.

Assaying: A Text-book of Practical Assaying. By J. Park. 8vo. Price, $2.50. J. B. Lippincott Co., Philadelphia.

Cyanogen: The Chemistry of Cyanogen Compounds and Their Manufacture and Estimation. By Herbert E. Williams. 8vo. 423 pp. Price, $3.50. P. Blakiston's Son & Co., Philadelphia.

Explosives: Les Poudres et Explosifs. Les mesures de sécurite dans les mines de Nouille. By L. Vennin and G. Chesnau. 8vo. Paris.

Gas: Gas Works Directory and Statistics, 1914-15. 8vo. 548 pp. Price, $3.00. Hazell, Watson & Viney, London.

General Chemistry: Chemistry of Familiar Things. By S. S. Sadtler. 8vo. 320 pp. Price, $1.75. J. B. Lippincott Co., Philadelphia.

General Chemistry: Elementary Practical Chemistry for Medical and Other Students. By J. E. Myers and J. B. Firth. 12mo. 194 pp. Price, $1.25. J. B. Lippincott Co., Philadelphia.

Inorganic Chemistry: A Text-book of Inorganic Chemistry. Vol. I., Pt. 1. An Introduction to Modern Inorganic Chemistry. Pt. 2. The Inert Gases. By J. Newton Friend and others. 8vo. 385 pp. Price, $3.00. J. B. Lippincott Co., Philadelphia.

Physiology: Directions for a Practical Course in Chemical Physiology. By W. Cramer. 2nd Ed. 4to. 102 pp. Price, $1.00. Longmans, Green & Co., New York.

Sewerage: American Sewerage Practice. Vol. 2. Design of Sewers. By Leonard Metcalf and Harrison P. Eddy. 8vo. 564 pp. Price, $4.00. McGraw-Hill Book Co., New York.

Technology: Lehrbuch der Chemie und chemische Technologie für Handelsakademein. By A. Chazel. 2. 8vo. 231 and 353 pp. Price, $2.00. Wien.

Vinegar: A Practical Treatise on the Manufacture of Vinegar. By W. T. Braunt, Editor. 3rd Ed. 8vo. 567 pp. Price, $6.00. H. C. Baird & Co., Philadelphia.

Water: Examination of Water for Sanitary and Technical Purposes. By Henry Leffman. 7th Ed. 12mo. Price, $1.25. P. Blakiston's Son & Co., Philadelphia.

Wood: The Preservation of Structural Timber. By Howard F. Weiss. 8vo. 312 pp. Price, $3.00. McGraw-Hill Book Co., New York.

RECENT JOURNAL ARTICLES

Air: Ueber Luftverunreinigung durch Kohlenoxyd, mit besonderer Berücksichtigung einiger weniger bekannter Quellen derselben. By Leo G. Meyer. *Archiv für Hygiene.* Vol. 84, 1915, No. 2, pp. 79–120.

Alcohol: Some Technical Phases of Alcoholic Fermentation. By W. L. Owen. Sugar, Vol. 17, 1915, No. 3, pp. 44–6.

Alkaline-Earths: Ueber die Peroxyde der Erdalkalien. By E. H. Riesenfeld and W. Nottebohm. *Zeitschrift für anorganische Chemie,* Vol. 90, 1915, No. 4, pp. 371–6.

Ammonium Chloride: Anlage zur Herstellung von Ammoniumchlorid aus technischen Salmiakgeist odor Konzentrierten Gaswasser. By G. Barnick. *Chemische Apparatur,* Vol. 2, 1915, No. 3, pp. 33–4.

Analysis: Ueber Metalltitrationen mittels Arsensäure. By J. Valentin. *Zeitschrift für analytische Chemie,* Vol. 54, 1915, No. 2, pp. 76–89.

Apparatus: Bemerkungen über Mischapparate. By Oskar Nagel. *Chemische Apparatur,* Vol. 2, 1915, No. 3, pp. 35–6.

Atomic Weights: Twenty-second Annual Report of the Committee on Atomic Weights. By Gregory Paul Baxter. *Journal of the American Chemical Society,* Vol. 37, 1915, No. 3, pp. 407–17.

Benzol: Gewinnung von Benzol aus Koksofengasen. By G. Barnick. *Chemische Apparatur,* Vol. 2, 1915, No. 1, pp. 1–4.

Blast Furnace: Filling the Blast Furnace. By J. E. Johnson, Jr. *Metallurgical and Chemical Engineering,* Vol. 13, 1915, No. 3, pp. 161–73.

Boiler Water: The Purification of Boiler Feed Water. By Everard Brown. *Metallurgical and Chemical Engineering,* Vol. 13, 1915, No. 3, pp. 156–60.

Calorimetry: Corrections in Bomb Calorimetry. By G. Nevill Huntly. *The Analyst,* Vol. 40, 1915, No. 467, pp. 41–8.

Copper: Die Struktur des Elektrolytisch abgeschiedenen Kupfers. By A. Sieverts and W. Wippelmann. *Zeitschrift für anorganische Chemie,* Vol. 91, 1915, No. 1, pp. 1–45.

Copper: Present Tendencies in Copper Metallurgy. By E. P. Mathewson. *Metallurgical and Chemical Engineering,* Vol. 13, 1915, No. 3, p. 141.

Cotton: Notes on the Various Methods of Finishing Cotton Goods, with the Most Recent Improvements and Economical Applications. By Raffaele Sansone. *The Textile American,* Vol. 23, 1915, No. 1, pp. 23–4.

Dyes: Fortschritte in der Herstellung und Anwendung von Küpenfarbstoffen während des letzten Jahres. By Franz Erban. *Färber-Zeitung,* Vol. 26, 1915, No. 3, pp. 32–7.

Ferrovanadium: The Determination of Manganese in Ferrovanadium. By William W. Clark. *Metallurgical and Chemical Engineering,* Vol. 13, 1915, No. 3, pp. 155–6.

Fertilizers: Ueber die chemisch-quantitative Zusammensetzung der Stassfurter Salzablagerungen. By Rózsa. *Zeitschrift für anorganische Chemie,* Vol. 90, 1915, No. 4, pp. 377–85.

Indigo: Einige Bemerkungen über die Erzielung weisser und roter Druckeffekte auf mit Indigo gefärbter Ware. By G. Tagliani und G. Arosio. *Färber-Zeitung,* Vol. 26, 1915, No. 1, pp. 1–3.

Knit Goods: Operating Costs and Economies in Knitting Mills. By C. E. Murray. *The Textile American,* Vol. 23, 1915, No. 1, pp. 25–6.

Lactic Acid: Analysis of Lactic Acid. By T. A. Faust. *Journal of the American Leather Chemists' Association,* Vol. 10, 1915, No. 2, pp. 73–8.

Milk: Condition of Casein and Salts in Milk. By L. L. Van Slyke and A. W. Bosworth. *Journal of Biological Chemistry,* Vol. 20, 1915, No. 2, pp. 135–52.

Milk: The Manufacture of Condensed Milk, Milk Powders, Casein, Etc. Discussion of Methods of Analysis. By R. T. Mohan. *Journal of the Society of Chemical Industry,* Vol. 34, 1915, No. 3, pp. 109–13.

Moisture: A New Chemical Hygrometer. By Eric K. Rideal and A. Hannah. *The Analyst,* Vol. 40, 1915, No. 467, pp. 48–54.

Nitrates: Production of Nitrates from Air, with Special Reference to a New Electric Furnace. E. Kilburn Scott. *Journal of the Society of Chemical Industry,* Vol. 34, 1915, No. 3, pp. 113–26.

Nitrous Acid: Nachweis und jodometrische Bestimmung der salpetrigen Säure in daniet verunreinigten Wässern. By L. W. Winkler. *Zeitschrift für Untersuchung der Nahrungs- und Genussmittel,* Vol. 29, 1915, No. 1, pp. 10–16.

Oils: Hydrogenation of Oils. By Victor J. Lumbard. *Journal of the American Leather Chemists' Association,* Vol. 10, 1915, No. 2, pp. 80–7.

Oils: Polymerised Drying Oils. By R. S. Morrell. *Journal of the Society of Chemical Industry,* Vol. 34, 1915, No. 3, pp. 105–9.

Oils: Sind die gehärteten Oele für den menschlichen Genuss geeignet. By Philipp O. Süssmann. *Archiv für Hygiene,* Vol. 84, 1915, No. 2, pp. 121–45.

Pasteurization: The Ability of Colon Bacilli to Survive Pasteurization. By S. Henry Ayers and W. T. Johnson, Jr. *Journal of Agricultural Research,* Vol. 3, 1915, No. 5, pp. 401–10.

Phosphorus: An Improved Method for the Estimation of Inorganic Phosphoric Acid in Certain Tissues and Food Products. By Robert M. Chapin and W. C. Powick. *Journal of Biological Chemistry,* Vol. 20, 1915, No. 2, pp. 97–114.

Radium: The Radium Situation. By Warren F. Bleecker. *Metallurgical and Chemical Engineering,* Vol. 13, 1915, No. 3, pp. 143-5.

Sea Water: Die Destillation des Meerwassers zur Gewinnung von Trink- und Gebrauchswasser. By Ernest Golz. *Chemische Apparatur,* Vol. 2, 1915, Nos. 1 and 2, pp. 5–7 and 17–9.

Stock Yards Wastes: Two Years' Tests Indicate Best Treatment for Chicago Stock Yards Wastes. Anonymous. *Engineering Record,* Vol. 71, 1915, No. 9, pp. 266–8.

Sugar: Sugar Industry of the Philippines. By C. W. Hines. *Sugar,* Vol. 17, 1915, No. 3, pp. 31–4.

Sugar: Ueber die Wirkung der Bleitannatklärung bei der polarimetrischen Untersuchung von Zucker-, Dextrin-, und Stärkelosungen. By J. Grossfeld. *Zeitschrift für Untersuchung der Nahrungs- und Genussmittel,* Vol. 29, 1915, No. 2, pp. 51–6.

Tanners: Tannery Problems for Tanners and Chemists. By W. R. Cox. *Journal of the American Leather Chemists' Association,* Vol. 10, 1915, No. 2, pp. 101–4.

Textiles: Die Veredlung von Baumwollwaren in Nordamerika. By Edgar Landauer. *Färber-Zeitung,* Vol. 26, 1915, No. 3, pp. 29–32.

Textiles: The Mercerization of Textiles. By H. A. Carter. *The Textile American,* Vol. 23, 1915, No. 1, pp. 35–8.

Trade Wastes: Maintenance of Sewers and Disposal Works Demands Treatment of Injurious Trade Wastes. By W. L. Stevenson. *Engineering Record,* Vol. 71, 1915, No. 9, pp. 256–60.

Ventilation: Some Results of the First Year's Work of the New York State Commission on Ventilation. By C.-E. A. Winslow and others. *American Journal of Public Health,* Vol. 5, 1915, No. 2, pp. 85–118.

Water: On the Action of Lead, Copper, Tin, Nickel, Zinc, and Aluminum on Water. 13. Lead. By W. P. Jorissen. *Chemical News,* Vol. 111, 1915, No. 2882, pp. 91–2.

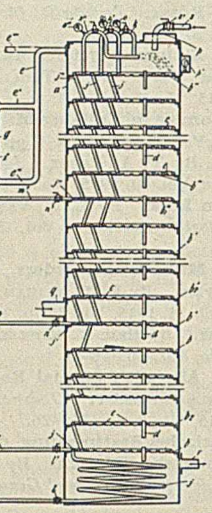
Wine: Ueber die Trübung von Weinen durch Eisenphosphatverbindungen. Hermann Weil. *Zeitschrift für Untersuchung der Nahrungs- und Genussmittel,* Vol. 29, 1915, No. 2, pp. 60–6.

RECENT INVENTIONS

UNITED STATES PATENTS

By C. L. Parker
Solicitor of Chemical Patents, Washington, D. C.

Separating Gaseous Mixtures into Their Constituents. R. P. Pictet, Dec. 1, 1914. U. S. Pat. 1,119,312. This process is primarily intended for the separation of air into oxygen and nitrogen. An upwardly moving stream of air is subjected in the apparatus illustrated, to the action of a descending stream of liquid nitrogen in a succession of liquid layers. This liquid nitrogen dissolves oxygen from the gaseous air and becomes progressively richer in oxygen. The layers of liquid nitrogen are then caused to boil by the action of a succession of streams of nitrogen forced into the apparatus at different heights and passing to the upper end through the liquid layers without mixing therewith. These streams of nitrogen are supplied under such different pressures that the nitrogen just liquefies at the temperature of the mixture of nitrogen and dissolved oxygen at the point of entry of the nitrogen.



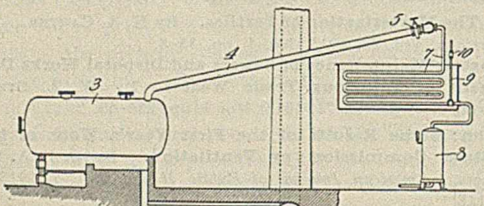
Carbon-Destroyer. A. A. Saxe, Dec. 1, 1914. U. S. Pat. 1,119,458. This composition for removing carbon from internal combustion engine cylinders consists of kerosene 5 gallons; benzol 2 gallons; alcohol 3 quarts; and spirits of camphor 1 quart.

Distilling Petroleum. E. M. Clark, Dec. 1, 1914. U. S. Pat. 1,119,496. Petroleum is distilled by circulating it forcibly and rapidly in a relatively small stream under confinement and subjecting it to a cracking temperature from and back to a bulk-supply of the liquid, taking off and condensing the resultant vapors and maintaining upon them a pressure of the vapors of about 3 to 7 atmospheres.

Composition for Laying Road-Dust. C. Ellis, Dec. 1, 1914. U. S. Pat. 1,119,500. The composition consists of concentrated waste sulfite liquor and a substantially tar-free oil.

Pure Oxid of Tin. G. Spitz, Dec. 1, 1914. U. S. Pat. 1,119,547. Pure tin oxid in its most amorphous condition is produced from stannate solutions by removing contaminating metals, precipitating the tin oxid, washing the precipitate with water and calcining it unmixed with acid.

Distilling Hydrocarbons. R. E. Humphreys, Dec. 1, 1914. U. S. Pat. 1,119,700. In this process products of low boiling points, such as gasoline, are produced from hydrocarbons of relatively high boiling points by distilling at a pressure of upward of four atmospheres, cooling the vapors while under pressure to condense the heavier fractions, simultaneously returning the condensed heavier fractions to the still for further treatment and leading off and condensing the light vapors.



Stable Colloidal Solutions of Metals. B. Schwerin, Dec. 1, 1914. U. S. Pat. 1,119,647. Silicic acid is mixed with a solution of the metal salt to be employed and the metal reduced with hydrazin hydrate.

Cleaning Compound for Metals. G. D. Feidt, Dec. 1, 1914. U. S. Pat. 1,119,781. The composition consists of phosphoric acid, alcohol, and carbon tetrachlorid.

Ink. R. Hochstetter, Dec. 8, 1914. U. S. Pat. 1,119,960. A pulp color is mixed with a varnish in a partial vacuum and at the same time subjected to a temperature sufficient to vaporize the mixture under the vacuum.

Hydrocarbon Liquid Suitable for Use in Internal-Combustion Engines. D. R. McArthur, Dec. 8, 1914. U. S. Pat. 1,119,974. Natural gas is subjected to compression and the heat resulting from such compression and commingled with a higher liquid paraffin in an atomized or vaporized condition. The resultant product condenses in the form of a liquid of lower specific gravity than that of the higher paraffin used.

Recovering Precious Metals. F. A. Wiswell, Dec. 8, 1914. U. S. Pat. 1,120,175. Pulverized ore or sand containing precious metals in fine particles is subjected to the action of an aqueous solution of mercuric chlorid in the presence of iron while subjecting the material to the action of an electric current.

Materials for Generating Hydrogen. S. Uyeno, Dec. 15, 1914. U. S. Pat. 1,120,768. An amalgam is produced by forming an alloy of aluminum, tin and zinc, rubbing the surface of the alloy with an amalgam of mercury and zinc and heating the resulting product to a relatively high temperature but below the boiling point of mercury.

Cream of Tartar. J. B. Moszczenski, Dec. 15, 1914. U. S. Pat. 1,120,839. Material containing potassium bitartrate is subjected to the action of a solution of sodium acetate at a high temperature to dissolve the potassium bitartrate. The solution is allowed to cool and the resulting crystals separated from the mother liquor.

Caoutchouc Substitute. O. Rohm, Dec. 15, 1914. U. S. Pat. 1,121,134. A solid acrylic acid ester obtained by polymerization is subjected to vulcanization.

Soluble Phosphates. J. W. Beckman, Dec. 15, 1914. U. S. Pat. 1,121,160. Alunite is heated to a reacting temperature with tricalcium phosphate.

Perborate of Zinc. W. Weber, Dec. 15, 1914. U. S. Pat. 1,121,428. Sulfate of zinc is melted with sodium perborate, while constantly stirring the mass.

Recovering Alkalis from Flue-Gases. S. B. Newberry. Dec. 15, 1914. U. S. Pat. 1,121,532. Flue dust from flued gases of cement kilns is leached with water and the solution caused to move over an extended surface in contact with a current of flue-gases in a direction contrary to the flow of the gases and in such manner that the solution will be concentrated by absorption of salts from the gases and by evaporation by their heat. The resulting concentrated solution is subjected to crystallization, the crystals withdrawn and the mother liquor employed for further contact with the flue-gases.

Hydrogenating Unsaturated Compounds. H. K. Moore, Dec. 22, 1914. U. S. Pat. 1,121,860. Separate streams of oil and hydrogen are brought into contact with a catalyzer and with each other, and the hydrogenated product separated from the catalyzer.

BRITISH PATENTS

By D. Geddes Anderson
Chemical Engineer and Patent Chemist, Glasgow, Scotland

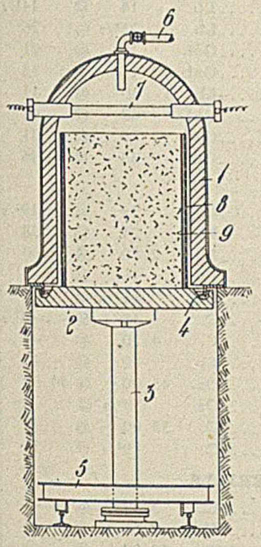
The following abstracts are taken direct from the patent specifications, as soon as these are published by the British patent office. The date given at the end of the abstract is date of acceptance.

Hydraulic Cementing Material. W. A. Oakley, Application, July 15, 1913. Brit. Pat. 16,243. Magnesium carbonate is added to hydrochloric acid (1 acid to 2 water), until no more will dissolve. The resulting solution is mixed with kaolin, dried at 120° F., and ground with burnt magnesite.—Accepted Jan. 7, 1915.

Separation of Metallic Sulfides. L. Bradford, Sept. 18, 1913. Brit. Pat. 21,104. This process deals in particular with the selective separation of zinc sulfides from lead sulfides. A differentiating medium, consisting of a solution of sodium chloride slightly acidulated is used, and it is found that the galena particles become "wetted," and are not then susceptible to flotation in such a medium. They are left as a high-grade leady residue, while the zinc sulfide (blende) particles are not "wetted" and a float concentrate high in zinc can be obtained.—Jan. 7, 1915.

Repairing Material for Pneumatic Tires. W. H. Halsall and P. Coulton, May 13, 1914. Brit. Pat. 25,997 of 1913. Material consists of a thin sheet of vulcanized india-rubber, and applied to one face is a thin layer of unvulcanized but vulcanizable rubber composition consisting of pure rubber 1 lb., sulfur 3 1/2 oz., French chalk 1 lb. The heat generated by the friction of the tire on the roadway vulcanizes the repairing material to the air tube.—Jan. 21, 1915.

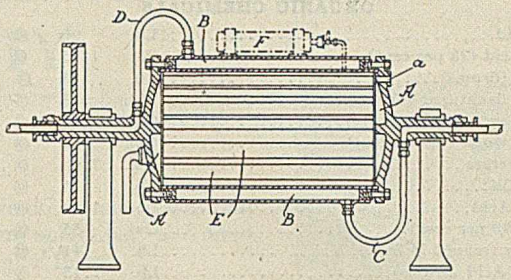
Furnace for Producing Cyanamides. Dettifoss Power Co., Ltd. and J. H. Lidholm, Dec. 11, 1913. Brit. Pat. 28,629. This furnace is stated to save time and electrical energy and to diminish labor charges. The furnace is provided with a bottom adapted to be raised or lowered, and on which the charge is placed in a vessel, in such manner that when the reaction is finished the charge may be removed, by lowering the bottom, and immediately replaced by a fresh charge: 2 is the bottom of the furnace lowered or raised by the hydraulic piston 3: 8 is the vessel for containing the charge of carbide, and 6 the inlet for nitrogen. The charge is lowered on to the carriage 5 and replaced by a fresh charge.—Jan. 14, 1915.



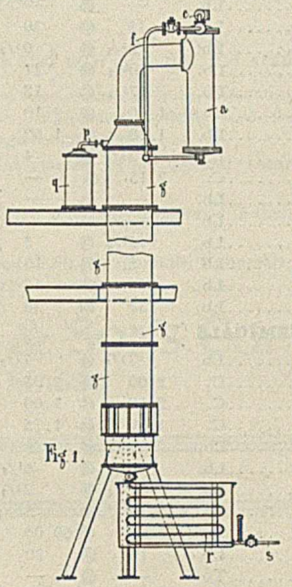
Recovery of Acid from Acid Sulfates. G. Hunnybun, Dec. 18, 1913. Brit. Pat. 29,254. One part of sulfur is heated with 2 parts acid sulfate. Sulfur dioxide and acid are evolved and collected in any usual manner.—Jan. 18, 1915.

Composition for Application to Surfaces Subjected to Friction. A. Elder, Dec. 31, 1913. Brit. Pat. 30,035. This is a mixture of 70 parts steel dust, 20 parts gutta percha, 5 parts rubber, 5 parts shellac. Mixture is rolled into ribbons and is heated before use. —Jan. 13, 1915.

Apparatus for Use in Impregnating Oils or Fats with Gases. A. H. Charlton, Jan. 19, 1914. Brit. Pat. 1410. The cylinder or drum "A" containing the oil and gas is supported on trunnions through which pass the steam inlet "C," and exhaust "D". The cylinder is provided on its inner periphery with a series of scoop-like members which, when the drum is rotated, lift up and throw back the oil. "B" is the steam packet and "F" a gas-containing cylinder.—Jan. 19, 1915.



Deodorizing Oils. J. T. Bateman, Jan. 6, 1914. Brit. Pat. 367. The oil flows from preliminary heater "a" into deodorizing chambers "g" where it comes into actual contact with superheated steam. "q" is a separate which collects any oil spray carried up with the steam. The oil passes down through chambers "g" into the cooling coil "y."—Jan. 6, 1915.



Utilization of Kelp. Boberg, Testrup, and Techno-Chemical Laboratories, Ltd., Jan. 22, 1914. Brit. Pat. 1766. The kelp is reduced to a pulp and forced under pressure through a heater in which its slimy water-binding constituents are destroyed by heat. The cooled, treated pulp is pressed, and the effluent contains most of the alkali salts and iodine.—Jan. 14, 1915.

Products from Rubber. F. E. Matthews and E. H. Strange, Jan. 26, 1914. Brit. Pat. 2070. Liquid sulfur dioxide is added to a cooled benzene solution of the soluble portion of synthetic or natural rubber, and the mixture warmed to a temperature of 40° C. in a sealed vessel. An elastic product is obtained.—Jan. 21, 1915.

Oil for Internal Combustion Engines. B. O. Jenkins, Feb. 14, 1914. Brit. Pat. 3899. A mixture of 25 per cent benzol, 70 per cent alcohol, 1 per cent camphoric acid distilled at 80° C. to 160° C. The camphor renders the liquid more volatile.—Jan. 14, 1915.

Puncture Sealing Composition for Pneumatic Tires. P. W. Owen, April 10, 1914. Brit. Pat. 8753. Flake mica or a mixture of flake mica and resin, is made into a paste with water and poured into the air tube of the tin through the valve opening. The mica forms an adhering film over the inner surface of the air tube. —Jan. 20, 1915.

Substitute for Laundry Starch. E. M. Newbery and E. A. Simpson, July 14, 1914. Brit. Pat. 16,774. Gelatin or other albuminoid is soaked in water and then boiled, and borax, white wax and formaline added. Product forms a stiff mass which can be used exactly as starch.—Jan. 7, 1915.

Application of Dyestuffs. E. Lodge and J. M. Evans, Sept. 5, 1914. Brit. Pat. 19,473. A sulfur color is reduced to its leuco compound by an alkaline sulfid in the presence of an alkaline sulfite, and a neutral salt of ammonia is added to the dye bath before the introduction of the material to be dyed. This process avoids strong alkalinity in the dyebath, and animal fibers can be dyed without drying. It is also applicable to the dyeing of artificial silks.—Jan. 28, 1915.

MARKET REPORT

AVERAGE WHOLESALE PRICES OF STANDARD CHEMICALS, ETC., FOR THE MONTH OF MARCH, 1915

ORGANIC CHEMICALS

Acetanilid	Lb.	90	@	95
Acetic Acid (28 per cent)	C.	1.75	@	2.00
Acetone (drums)	Lb.	18	@	20
Alcohol, denatured (180 proof)	Gal.	33	@	35
Alcohol, grain (188 proof)	Gal.	2.50	@	2.54
Alcohol, wood (95 per cent)	Gal.	45	@	47
Amyl Acetate	Gal.	2.60	@	2.70
Aniline Oil	Lb.	75	@	85
Benzoic Acid	Lb.	1.10	@	—
Benzol (90 per cent)	Gal.	55	@	—
Camphor (refined in bulk)	Lb.	41 1/2	@	—
Carbolic Acid (drums)	Lb.	1.15	@	1.50
Carbon Bisulfide	Lb.	6 1/2	@	7 1/2
Carbon Tetrachloride (drums)	Lb.	14	@	15
Chloroform	Lb.	30	@	35
Citric Acid (domestic), crystals	Lb.	55	@	57
Dextrine (corn) (carloads, bags)	C.	2.93	@	—
Dextrine (imported potato)	Lb.	—	@	—
Ether (U. S. P., 1900)	Lb.	15	@	20
Formaldehyde	Lb.	8 1/2	@	9 1/2
Glycerine (dynamite)	Lb.	20 1/2	@	21
Oxalic Acid	Lb.	17 1/2	@	18
Pyrogallic Acid (bulk)	Lb.	1.90	@	2.10
Salicylic Acid	Lb.	1.50	@	1.60
Starch (cassava)	Lb.	3 1/4	@	4
Starch (corn) (carloads, bags)	C.	2.15	@	—
Starch (potato)	Lb.	—	@	—
Starch (rice)	Lb.	—	@	—
Starch (sago)	Lb.	2 7/8	@	3
Starch (wheat)	Lb.	5	@	10
Tannic Acid (commercial)	Lb.	60	@	66
Tartaric Acid, crystals	Lb.	37	@	38

INORGANIC CHEMICALS

Acetate of Lead (brown, broken)	Lb.	7 1/4	@	7 1/2
Acetate of Lime (gray)	C.	2.00	@	2.05
Alum (lump)	C.	2.50	@	3.00
Aluminum Sulfate (high-grade)	C.	1.50	@	1.75
Ammonium Carbonate, (domestic)	Lb.	8 1/4	@	9
Ammonium Chloride, (gray)	Lb.	5 1/2	@	6 1/2
Aqua Ammonia (drums) 16°	Lb.	2 1/4	@	2 1/2
Arsenic (white)	Lb.	4	@	5
Barium Chloride	Ton	55.00	@	60.00
Barium Nitrate	Lb.	16	@	20
Barytes (prime white, foreign)	Ton	—	@	—
Bleaching Powder (35 per cent)	C.	1.37 1/2	@	1.50
Blue Vitriol	Lb.	5 3/4	@	6
Borax, crystals (bags)	Lb.	4 1/4	@	4 3/4
Boric Acid, crystals (powd.)	Lb.	7 3/4	@	10
Brimstone (crude, domestic)	Long Ton	22.00	@	22.50
Bromine (bulk)	Lb.	40	@	50
Calcium Chloride (lump)	Ton	11.70	@	12.00
Chalk (light precipitated)	Lb.	4 1/2	@	5 1/2
China Clay (imported)	Ton	14.00	@	18.00
Feldspar	Ton	8.00	@	14.00
Fuller's Earth (powdered, foreign)	C.	80	@	90
Green Vitriol (bulk)	C.	30	@	32
Hydrochloric Acid (18°)	C.	1.15	@	1.65
Iodine (resublimed)	Lb.	4.20	@	4.50
Lead Nitrate	Lb.	8	@	—
Litharge (American)	Lb.	5	@	5 1/4
Lithium Carbonate	Lb.	1.00	@	1.10
Magnesium Carbonate	Lb.	4 1/2	@	4 3/4
Magnesite "Calcined"	Ton	nominal		
Nitric Acid (36°)	Lb.	3 7/8	@	4 1/4
Phosphoric Acid (sp. gr. 1.75)	Lb.	28	@	28 1/2
Phosphorus	Lb.	35	@	95
Plaster of Paris	Bbl.	1.50	@	1.70
Potassium Bichromate	Lb.	13	@	15
Potassium Bromide	Lb.	70	@	80
Potassium Carbonate (calcined), 80 @ 85%	C.	14	@	14 1/2
Potassium Chlorate, crystals spot	Lb.	40	@	45
Potassium Cyanide (bulk), 98–99%	Lb.	22	@	35
Potassium Hydroxide	Lb.	14	@	14 1/2
Potassium Iodide (bulk)	Lb.	3.15	@	3.25
Potassium Nitrate (crude)	Lb.	—	@	—
Potassium Permanganate (bulk)	Lb.	25	@	30
Quicksilver, Flask (75 lbs.)		—	@	—
Red Lead (American)	Lb.	5 1/2	@	6
Salt Cake (glass makers')	C.	55	@	65
Silver Nitrate	Oz.	31 3/4	@	33 1/2
Soapstone in bags	Ton	10.00	@	12.00
Soda Ash (48 per cent)	C.	67 1/2	@	72 1/2
Sodium Acetate	Lb.	4	@	4 1/2
Sodium Bicarbonate (domestic)	C.	1.00	@	1.10
Sodium Bicarbonate (English)	Lb.	3 1/2	@	4
Sodium Bichromate	Lb.	4	@	4 1/2
Sodium Carbonate (dry)	C.	60	@	80
Sodium Chlorate	Lb.	16	@	—
Sodium Hydroxide (60 per cent)	C.	1.55	@	1.57 1/2
Sodium Hyposulfite	C.	1.60	@	1.90
Sodium Nitrate (95 per cent, spot)	C.	2.20	@	2.25
Sodium Silicate (liquid)	C.	85	@	1.15
Strontium Nitrate	Lb.	15	@	17
Sulfur, Flowers (sublimed)	C.	2.20	@	2.60
Sulfur, Roll	C.	1.85	@	2.15
Sulfuric Acid (60° B)	C.	85	@	1.00
Talc (American)	Ton	15.00	@	20.00
Terra Alba (American), No. 1	C.	75	@	80
Tin Bichloride (50°)	Lb.	11	@	12
Tin Oxide	Lb.	48	@	—
White Lead (American, dry)	Lb.	5	@	5 1/4
Zinc Carbonate	Lb.	8 1/2	@	9
Zinc Chloride (granulated)	Lb.	4 1/2	@	4 3/4
Zinc Oxide (American process)	Lb.	5 3/8	@	6 3/8
Zinc Sulfate	C.	2.50	@	—

OILS, WAXES, ETC.

Beeswax (pure white)	Lb.	45	@	57
Black Mineral Oil, 29 gravity	Gal.	12 1/2	@	13
Castor Oil (No. 3)	Lb.	8 1/4	@	9
Ceresin (yellow)	Lb.	10	@	25
Corn Oil	C.	6.26	@	6.31
Cottonseed Oil (crude), f. o. b. mill	C.	5.53	@	5.60
Cottonseed Oil (p. s. y.)	Lb.	6 3/4	@	7
Cylinder Oil (light, filtered)	Gal.	20	@	25
Japan Wax	Lb.	12	@	15
Lard Oil (prime winter)	Gal.	92	@	94
Linseed Oil (raw)	Gal.	55	@	—
Menhaden Oil (crude)	Gal.	37	@	39
Naphtha, 68 @ 72°	drums	—	@	12
Neatsfoot Oil (20°)	Gal.	95	@	98
Paraffine (crude, 120 & 122 m. p.)	Lb.	2 1/2	@	3
Paraffine Oil (high viscosity)	Gal.	22	@	23
Rosin ("F" grade) (280 lbs.)	Bbl.	3.55	@	3.60
Rosin Oil (first run)	Gal.	25	@	—
Shellac, T. N.	Lb.	14	@	14 1/2
Spermaceti (cake)	Lb.	25 1/2	@	26
Sperm Oil (bleached winter), 38°	Gal.	70	@	71
Spindle Oil, No. 200	Gal.	17	@	18
Stearic Acid (double-pressed)	Lb.	10	@	11
Tallow (acidless)	Gal.	62	@	63
Tar Oil (distilled)	Gal.	30	@	31
Turpentine (spirits of)	Gal.	45	@	46

METALS

Aluminum (No. 1 ingots)	Lb.	19	@	19 1/2
Antimony (Hallet's)	Lb.	24	@	28
Bismuth (New York)	Lb.	2.80	@	2.90
Bronze powder	Lb.	—	@	—
Copper (electrolytic)	Lb.	14 7/8	@	15
Copper (lake)	C.	15	@	15 1/2
Lead, N. Y.	C.	4.10	@	—
Nickel	Lb.	42	@	45
Platinum (refined)	Oz.	45.00	@	50.00
Silver	Oz.	50 1/2	@	—
Tin	C.	53.00	@	—
Zinc	C.	9 3/4	@	10

FERTILIZER MATERIALS

Ammonium Sulfate	C.	3.19	@	—
Blood (dried)	Unit	2.65	@	—
Bone, 4 1/2 and 50 (ground, raw)	Ton	30.00	@	—
Calcium Cyanamid	Unit of Ammonia	2.20	@	—
Calcium Nitrate (Norwegian)	C.	—	@	—
Castor meal	Unit	—	@	—
Fish Scrap (domestic, dried)	Unit	—	&	—
Phosphate, acid (16 per cent bulk)	Ton	7.00	@	—
Phosphate rock; f. o. b. mine:				
Florida land pebble (68 per cent)	Ton	2.25	@	2.50
Tennessee (70–80 per cent)	Ton	5.00	@	5.50
Potassium, "muriate," basis 80 per cent	Ton	1.15	@	1.25
Pyrites (furnace size, imported)	Unit	12 1/2	@	—
Tankage (high-grade)	Unit	2.65	&	10