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PREPARATION FOR AFTER THE WAR

The beginning of the end is at hand. A bitter four-year struggle has sufficed to indicate clearly the peak of potency of that great military machine which was shot through with the conviction that *might* must triumph. Little did the leaders of the Teutonic hordes realize what possibilities of resistance lay in the spirit of free men. Strengthened now with the ever increasing impetuous hosts of Americans the armies of the Entente Allies are steadily driving back the enemy, giving no time for recovery of strength, no opportunity for such concentration of forces as might prove an effective resistance. Filled with the conviction that only "Unconditional Surrender" will satisfy those who have been eye-witnesses of the many crimes against humanity, our men are hastening their steps toward Berlin. Doubtless many obstacles will be thrown in the path of that mighty advance; it may be retarded from time to time but it cannot be stopped. How long this final stage will last no one can predict, but no one doubts its finality.

With the advent of peace new adjustments of our present abnormal life will be immediately required. Especially will this be true for chemists whose entire activities have been so directly centered on war problems. During this war period chemistry has come into its own in this country, and the responsibilities are thereby increased as to the wise solution of those large problems which will confront us during the early days of the peace period.

With characteristic foresightedness Dr. B. C. Hesse, a member of the Committee Advisory to the President and a councilor-at-large, prepared an address on this subject which was to have been delivered before the Philadelphia Section. Unfortunately the ravages of the prevailing epidemic have made impossible the holding of the meeting at which the address was to have been read. We are glad to be able to print the address as the special feature of this issue, and would urge its careful and thoughtful reading by every member of the AMERICAN CHEMICAL SOCIETY.

In this address Dr. Hesse has dared "to think out loud," regardless of whether or not his thoughts may be sound, an example well worthy of imitation if progress is to be made. Without seeking to divert in the slightest the minds of chemists from those problems directly connected with the winning of the war, he points out that

> In the tense industrial, commercial, and financial world-wide struggle that is bound to ensue directly after the close of hostilities, success will in all probability fall in a greater measure to those who have, in advance, prepared a comprehensive workable plan adapted for immediate development and operation, and sufficiently elastic to allow of effective adaptation to changing or unforeseen conditions, than to those who have not so prepared themselves.

In the preparation of such a plan it is urged that the councilors in consultation with the members of their respective local sections prepare lists of suggestions for future activities and comment in a spirit of constructive criticism upon the suggestions made by others. Often during the past few months members have commented upon the difficulty in securing speakers for the meetings of the coming winter. Might it not be well to vary these programs and occasionally to do without speakers, devoting the time instead to informal discussion of after-war problems?

The councilors of the Philadelphia Section were so much impressed by the spirit of Dr. Hesse's address that they have already started action. A letter from Dr. J. Howard Graham, the Secretary of that Section, informs us that the following plan has been adopted:

> That a letter be printed and sent to all chairmen and secretaries of the 54 sections, calling attention to preprints mailed under separate cover, and especial attention to pages 3 and 14 of the same, and urging that the preprints be sent immediately to all councilors, and that suggestions for plans for "Preparation for After the War," be sent through the secretaries to me so that our council might boil them down, eliminate duplicates, and forward them in bound form to the general council for their consideration. A personal and typewritten letter is also to be sent to the 54 secretaries urging their coöperation to the utmost of their time, and calling attention to the fact that the Philadelphia Section, realizing the importance of the movement, has simply agreed to act as a clearing-house for the many suggestions that we believe it possible to make.

This action of the Philadelphia Section provides the machinery for a thorough interchange of opinion, and for a compilation of suggestions which should prove of inestimable value to those who may be charged, perhaps suddenly, with the responsibility of presenting the views of chemists upon after-war problems, and of formulating those measures which will lead truly to greater usefulness of our science to our country, a peace service just as obligatory upon us as is the splendid war service now being given.

In no whit, however, is it intended that these discussions of after-war problems should interfere with that concentrated effort needed to furnish an abundance of those products of the chemist's skill which, at the least sacrifice of the lives of our men, will wring from the enemy the only words which will satisfy our people—"Unconditional Surrender!"

DEVELOPMENTS IN CERAMICS

The clothes became too small for the growing body, hence the American Ceramic Society decided to discard the annual volume of "Transactions" with which it formerly was content and to issue instead a monthly periodical, *The Journal of the American Ceramic Society*.

The editor is Dr. George H. Brown of Rutgers College, New Brunswick, N. J., and associated with him is the Committee on Publications: Drs. L. E. Barringer, *chairman*, A. V. Bleininger, H. Ries, and E. W. Tillotson.

In spite of the restrictions placed upon the ceramic industry by the Fuel Administrator, abundant signs exist of unusual activities in this field which give rich promise for its future. Outward evidences of this activity are noted in the creation of the School of

Ceramics, with its special building, at the University of Illinois, under the leadership of Dr. E. W. Washburn; the segregation of the ceramics exhibits at the recent Exposition; the resignation of Dr. Arthur L. Day from the directorship of the Geophysical Laboratory in order to undertake research for one of the great glass companies, already markedly successful in its efforts to render America independent in glassware.

The mention of the names of Drs. Day and Washburn in connection with this industry emphasizes again the increasing call of the industries for physical chemists in industrial research, and this in turn brings us back to the responsibility resting upon universities to lay stress upon physical chemistry in the curriculum for the chemists of the future.

COMMISSIONS FOR BASEBALL PLAYERS

Many letters have been received containing unfavorable comments on the appointment of well known baseball players to commissioned offices in the Chemical Warfare Service. Complaint is made that this tends to lower the dignity of the chemical profession and to work an injustice to men who have spent years in chemical training, yet who still rank as privates or non-commissioned officers.

We must confess to an inability to sympathize with these criticisms, and do not believe that this is in any wise due to a natural predilection for baseball players. The Service in question is not a Chemical Service, but a Chemical Warfare Service. Its personnel numbers approximately thirty thousand. As there are only some sixteen thousand chemists recorded in the country, and as many of these are still connected with the industries, it is evident that a considerable majority of the members of the Chemical Warfare Service are not chemists.

Furthermore, while the work of the chemist is the all-important foundation of this division of the War Department, there is also the important function of applying the results of the chemists' work most forcefully to the enemy in the offensive and to our own soldiers in the defensive. For this work natural leaders are desired, men of proved personality, of fine physique and undoubted personal courage.

In the light of the requirements we congratulate the Chemical Warfare Service on the appointments, confident that these officers will command the respect of the men in the field, will hold their nerve at every critical moment, and will contribute their full measure of terror to the enemy as he increases his backward pace through the liberated lands of France and Belgium.

No, let's not worry about that matter. A much larger and far more important problem remains unsolved, namely, the most efficient utilization of the service (we mean service and are not thinking about the matter of commissions) of the chemists already in uniform. We met one last week, known to us for years, who is doing mere clerical work which could be done by any man of average intelligence without the slightest knowledge of chemistry; two others were unloading box cars at a well-known arsenal. Still other men, of marked attainments, while nominally engaged in chemical work, are really put at tasks which the tyro could perform just as well.

It has been stated that the government requirements for next year call for two thousand additional chemists. A systematic search for these should begin within the ranks of all branches of the service. We believe that a good "shaking down" would reveal many such men qualified for the work in mind, now engaged in less important tasks. We have preached efficiency; we must practice it.

A RECORD OF ACHIEVEMENT

The dyestuff census compiled for the Bureau of Foreign and Domestic Commerce by Dr. Thomas H. Norton in 1916 gave for the first time, and with reasonable accuracy, an itemized statement of our importation of coal-tar dyes. It was a sketch in detail of our dependency, and has proved a valuable guide in the development of the new American industry.

The "Census of Dyes and Coal-Tar Chemicals, 1917," just issued by the U. S. Tariff Commission as Tariff Information Series—No. 6, is a record of achievement during the intervening time, of which all Americans may be proud.

In planning for the future of the industry, opinion may be replaced by facts, carefully collected and clearly presented in this new census. The formidable list of one hundred and ninety manufacturers shows how widespread is the activity in this line.

Every chemist, whether or not connected with the industry, will find interest in Part II, a concise and accurate twelve-page "History of the Dye Industry in the United States Since the Beginning of the European War."

While we are waiting to learn the character of the report the Tariff Commission will make to the Ways and Means Committee as a result of this study, will not someone inform us as to what is a "dyestuff," particularly as differentiated from a dye? We confess to very loose practice in the indiscriminate use of the two words, chiefly because we have been unable to find two authorities who agree.

CONSERVATION BEGINS AT HOME

The little girl had been almost worrying the life out of us to secure every particle of tin foil in the cigarette boxes. The enthusiasm of the six-year-old conservationist was due to the fact that "the Government wanted tin and asked everybody to save it." The twofold source of the request changed the worry into pleasure and we reached the office feeling just a bit a better citizen. There on the desk was a pile of editorial preprints, three pages each, and held together at one corner by an effective though scarcely visible tin-coated clip. On the other side of the desk was the morning mail, the top letter of which was a three-page communication, a form letter, from a government bureau in Washington. Almost dazzling to the eye was the huge tin-coated fastener which held the three sheets together. It was a complicated affair, but we were interested not so much in its ingenuity and complexity as in the unusual and unnecessary bulk. The habits of the laboratory returned, and the two clips were weighed, with the following result:

Weight of preprint clip = 0.0220 gram
Weight of government bureau clip = 6.6435 grams

To make sure, the matter was followed a step further and the little clip and a portion of the huge one were each dissolved in hydrochloric acid (it was good to get hold of a test tube again), and the solutions tested qualitatively for tin. The one showed a slight amount, the other an abundance. Quantitative tests were not necessary as the preprint clip was round, the other flat, therefore the 300 per cent ratio was sure to be increased, and it was bad enough as it was. The only way we could help the situation immediately was to buy another package of cigarettes and save the tin foil for the little girl; but we did gather a clearer idea of what a friend meant when he said: "I don't care how much they tax me for carrying on this war, if the funds are applied efficiently toward winning the war."

ANOTHER IDOL SHATTERED

The fetish of Teutonic superchemistry is receiving some hard blows nowadays. In laboratories and in plants results are being achieved which will act as pincers, forcing German retirement just as truly and as effectively as the successive blows of our armed forces are to-day by a similar process bringing near the day of complete victory.

The debt of Germany to other countries for the basic ideas on which its chemical industry is founded is being constantly illuminated by many recently published articles. Someone familiar with all the facts should write an article on Germany's debt to the American chemical industry, legally and illegally incurred, as a result of the tour of German chemists through the plants of this country immediately after the Eighth International Congress of Applied Chemistry in New York City in 1912.

While waiting for that story it may be well to record in the chemical literature another instance of German inspiration drawn from American environment and example. In 1914 the U. S. Bureau of Foreign and Domestic Commerce published a monograph, Special Agents Series No. 78, entitled "Commercial Organizations in Germany," by Archibald J. Wolfe. From page 50 of that publication the following is reproduced, the italics being ours:

> Verein Zur Wahrung Der Interessen Der Chemischen Industrie Deutschlands. The chemical industry is one of the best organized in Germany. The interests of all the chemical trades are served by this one central organization, with headquarters at Berlin. Closely allied to it are the Association of Fertilizer Manufacturers, at Hamburg; the Syndicate of Soda Manufacturers, at Bernburg; and the Association of Lead Paint Manufacturers, at Cologne. It has 290 active members (manufacturing concerns) and 138 personal members, who are heads of manufacturing establishments. The annual income of the association is about 60,000 marks ($14,280), of which 14,000 marks ($3,330) are expended on the official organ of the organization, *Die Chemische Industrie,* and 24,000 marks ($5,710) on the administration. Its official organ is one of the high-grade, well-edited German trade publications.
>
> *The impetus to the formation of this association was given at the Philadelphia Exposition [1876] when several representatives of the German chemical industry met at the banquet given by the AMERICAN CHEMICAL SOCIETY to their foreign colleagues.* It was decided at that informal meeting to form an association for the protection of the common interests of the chemical industry in customs and taxation matters. The scientific interests of the industry had been well served up to that time by the German Chemical Society, but it was only in later years that the German chemists effected a closer alliance between the scientific laboratory and the manufacturing establishment. A convention of all manufacturers and scientists interested in the chemical industry was called at Frankfort-on-the-Main in 1877, in order to found an association for the protection of the interests of that industry, particularly as at that time the entire economic legislation of Germany was undergoing a change. This association has been active, and successfully so, in representing the interests of the chemical industry in the matter of customs tariffs, taxation of industries, negotiation of commercial treaties, classification of chemicals for freight rates, patent and trade-mark laws, and in labor legislation and labor difficulties. The organization is remarkable for the liberal treatment extended to foreigners. Foreign scientists and other foreigners having an interest in the technical phases of the chemical industry are admitted as members, and may attend the session of the Association, but have no right to vote. Permanent commissions for matters requiring special study are organized under the auspices of the society, among them commissions for patents and trade-marks, for customs tariffs, for the investigation of complaints of individual manufacturers against acts of local authorities, etc.
>
> The membership fee in the association has been increased from time to time, and is based on the annual pay roll of each concern. The minimum is 25 marks ($5.95) and the maximum 500 marks ($119) per annum. It has organized an important employees' insurance association for the chemical trade. Its statistical bureau tabulates in the most detailed manner not only the production in the chemical industry, but also the wage scales. It publishes an accurate directory of the chemical industry.

An AMERICAN CHEMICAL SOCIETY banquet is capable of producing almost anything, but we did not know that it was in such a genial and at that time friendly atmosphere that the "Verein zur Wahrung, etc.," had its birth.

Even at that date, the initial year of existence of the AMERICAN CHEMICAL SOCIETY, the Manufacturing Chemists' Association of the United States had already passed some eight or ten years of useful life.

Travel is a great educator!

PERNICIOUS ACTIVITY

In the midst of these strenuous abnormal times even our printer's devil had to run amuck. After we had approved a correct setting of the heading to the Exposition section of the October issue he slipped one over on us, too late for correction, and made the heading read "Fourth National Exposition of Chemical *Engineers.*"

That none of our readers have called attention to the slip we take as an evidence of good-will, or perhaps as an indication that chemists, unlike newspaper readers in general, pay no attention to headlines.

After all, the little imp may have had the serious purpose of upsetting convention and giving credit to those to whom credit is due, for it was only through the work of chemical engineers that the Exposition was possible.

OUR PREPARATION FOR AFTER THE WAR

Address prepared by BERNHARD C. HESSE for the Philadelphia Section of the AMERICAN CHEMICAL SOCIETY, October 17, 1918

The AMERICAN CHEMICAL SOCIETY has long since completed its preparations for active assistance in our war; its participation is in full swing and operation and is capable of all needful expansion. The real business now in hand is for each of us to contribute all that we can to every effort to bring the war quickly to a successful issue.

However, all the belligerent countries, including our own, have been engaged for some time past, and in more or less official manner, in tentatively considering after-the-war conditions and how best to provide for them. Some of these tentative conclusions have found their way into print. Due to this necessary tentativeness all these discussions leave a feeling of confusion on a great many points, yet in them there clearly stands forth the unanimous decision that hereafter *each* nation must be as independent of all other nations as its resources in men, minds, and materials will enable it to become.

Our own Government has not yet, so far as I am aware, given out any statement as to what it may or may not be thinking of for after the war. In view of the greatly increased public appreciation of and wholesome interest in chemical endeavor as a factor in our national life, it seems highly improbable that the chemical requirements of our nation will not be thoroughly considered in any such plans. Further, it is not inconceivable that the AMERICAN CHEMICAL SOCIETY with its more than 12,000 members, meeting in 54 local sections in 33 states of the union, may be called upon for assistance, not only in the making of such plans, but also in their execution.

Whether so called upon or not, it is clear that in consequence of the very great changes and gigantic readjustments that will then surely take place in the economic life of practically the entire world, the AMERICAN CHEMICAL SOCIETY and all its members will find ready to hand many problems of varying scope that must be solved by us, and solved right and fairly promptly, and which are not connected with Government functions in any way, if we wish to live up to the proper and just demands of loyal citizenship and of professional responsibility. No doubt there will be many who will then believe in close affiliation with or even in actual control by the Federal Government of many matters which others will regard and have heretofore regarded as belonging to non-governmental agencies solely.

In the tense industrial, commercial, and financial world-wide struggle that is bound to ensue directly after the close of hostilities, success will in all probability fall in a greater measure to those who have, in advance, prepared a comprehensive workable plan adapted for immediate development and operation, and sufficiently elastic to allow of effective adaptation to changing or unforeseen conditions, than to those who have not so prepared themselves.

When that time comes, neither the AMERICAN CHEMICAL SOCIETY nor the American chemical profession should be found among the unprepared. But it would be an entirely mistaken policy for us to become so intent upon after-the-war preparedness that we were thereby and in any way to neglect, overlook, or omit even a single win-the-war activity. I am convinced that there is much of such preparation that we can do without taking any of our attention from the paramount business before us. Necessarily, some of these preparations are now in nebulous outline only, but they can undoubtedly be made sufficiently concrete for effective treatment if we seriously take counsel among ourselves betimes.

RESPONSIBILITY RECIPROCAL

It is clear that when time comes for action on behalf of the AMERICAN CHEMICAL SOCIETY such action will have to be determined and taken, and perhaps taken promptly, by a relatively small number of persons; they can act the more intelligently for the Society the better informed they are of the thought of our members on such subjects. There is therefore a reciprocal responsibility. Our Society officers must get the views of the members and the members must get their views to their officers. What individuals will have to act for the Society at such time is now unknown. Hence, members should proceed now or with as little delay as possible to formulate as well as they can what they want done and get it in such shape that it can be revised from time to time and promptly handed over in as concrete shape as possible to those who will have to carry the burden, when that time comes.

To do this calls in the first instance, at least, for no new machinery nor committees nor appointments. Our splendid Society organization is admirably adapted to take on that load. Our Council is an advisory body to our Directors and to our executive officers. Each of our local sections has a councilor for every 100 of its members or fraction of 100 members. In addition, we have 12 councilors-at-large. This machinery ought to enable us to get something concrete together in a relatively short space of time.

PROPOSED GENERAL PLAN OF ACTION

As I see it, if the councilors of each Local Section will get the views of the members of their respective sections and will put them into one document with a separate and consecutively numbered paragraph for each recommendation, these 54 documents can then be thrown into one document of numbered paragraphs, and this single document can go back to the local councilors for additions, if need be. In that way we will have compressed into a small space the ideas of all our individual members and make them, therefore, promptly available for comprehensive analysis and treatment. Even so, we must not look for a complete job at the first trial, and while reasonable care should be taken at this first attempt yet the work should not be held up merely because it is not a polished job in all respects. Before a job like this is finished there will have to be a lot of "ironing out" of rough places. Yet it can be done. It has been done, but of course on a much smaller scale, by the New York Section in respect of the three symposiums held by it on the relations between universities and the industries.[1] That résumé does not pretend to offer a complete solution but it nevertheless is an accurate and workable summary of the papers there treated. This is the same kind of a job, only *very* much larger. With such a document before them our executive or other officers acting for us at that time can proceed with greater confidence, than they otherwise could, that they are acting in reasonable accord with the best obtainable judgment of our members and our members could then look forward to such action, assured that their proposals had all been given consideration.

With me personally this is not wholly an academic or supposititious matter. If the time for action comes before January 1, 1920, I, as a member of the Advisory Committee to the President of the AMERICAN CHEMICAL SOCIETY, will, no doubt, have to bear my proper share of responsibility for decisions reached and actions taken on behalf of our Society. There is ample room for errors both of commission and omission. Whenever I consider the large number of new and strange problems that may come up at such a time I confess I become somewhat uneasy. On some subjects I have very definite convictions, on others I am less certain of myself, and on still others I have neither information nor opinion. Withal there is the uncertainty arising from the question that applies to each problem: "What do the members think about this?" And, again, there is the vexing question: "Have I overlooked anything vital?" With a document obtained as above outlined before me there is no doubt in my mind that I could and would act, with far greater confidence than otherwise, that I was properly considering the best judgment of the membership and that I was acting in the light of the best and most comprehensive information and help obtainable from our members. Beyond question such a document would be of great help to me personally and I cannot imagine that it could fail to be so for all those who will have to act in a similar capacity, although I am in no wise speaking for them nor any of them but myself.

MEMBERS INDIVIDUALLY RESPONSIBLE

These are extraordinary times and call for extraordinary measures. The membership must take extraordinary steps to get its views on these topics before those upon whom the burden of wise decision and effective execution must fall. Any member who has ideas on these subjects and fails to get them before his councilors is not "toting fair." Each of us must regard himself as a Committee of One to do this job and do it promptly. We owe this to our country, to our profession, and to ourselves.

I am making this suggestion to the membership as a whole, because I am thoroughly convinced that if I did not do so I would fall far short of dealing fair with the members who have honored me with their confidence by placing me among the councilors-at-large and upon the Advisory Committee to our Society's president.

When time for action comes we will be standing upon the threshold of a new order of things. We must leave nothing undone that can be done to make sure that those who are to carry our burdens for us have then been given every help that it is within our power to give. Coöperative effort the world over will take on new impetus and we must not fall behind the new standards of efficiency and coöperation that the world will then begin to set. Our aim should be to lead in this effort and not to trail after anyone. We cannot then afford to experiment very much; we should get things right the very first time.

Of course, those who will have to make the decision will have the advantage of being guided by events as they then stand, whereas any attempt now to reach a decision as to desirable or needful policies will be disadvantaged by the absence of the event. Nevertheless, there must be certain fundamental policies that will have to be settled regardless of the specific event and as to which there is legitimate present difference of opinion. These we should decide as far in advance as possible so that we will have much of our talking out of the way and permit our getting down to action along these predetermined lines and to meeting new problems as they arise.

In order to visualize and to make as concrete as I now can what in general and in part is in my mind I will proceed to illustrate, with as little detail as may be, some of the problems that have presented themselves to me.

Broadly, these divide themselves into two classes: internal and external, and under each are the two subheads, with or without co-action with our Government, Federal or otherwise; some are of a mixed nature. I shall not now attempt to arrange this material in any rigidly logical or connected order for I regard that at present more a hindrance than a help.

DIRECTED GROWTH OF CHEMICAL KNOWLEDGE

Our Society was organized in 1876 for the "advancement of chemistry and the promotion of chemical research." Through its general meetings, the meetings of its Local Sections, and the publication of three separate journals, much has been done toward disseminating chemical knowledge among American chemists and providing efficient vehicles of scientific record and communication. This is no small accomplishment. But that is now out of the way and is running itself. Can we not now do something new that is just as necessary as the above was in 1876, and just as nebulous and difficult as the problems then tackled? Shall we continue merely to be a recording agency and a means of communication? Can we not take an active and effective part in determining, at least in some degree, how and in what directions and to what extent chemistry shall advance and chemical research shall be promoted? Are we to-day engaged

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[1] THIS JOURNAL, 8 (1916), 658.

in the kind of pioneer work that the founders of our Society did in 1876? I am inclined to think that the answer must be "No!" that is, we are not breaking new ground, although we are very effectively cultivating old ground. Ought we not do more? I think the present war has taught us that we should and must.

Certainly, the creative part of research, in its truest sense, we cannot expect to control or guide. Nevertheless, it is of importance to the country and to our science, once a general reaction or property has been discovered, say, by Mr. A, that the full details and scope thereof shall become known and recorded with the least delay. Why should not Mr. A (or Miss A, for that matter) be placed in a position where, through the coöperation of others, those details can be promptly worked out carefully and under good supervision? There is no insuperable obstacle to giving A credit for the reaction and B, C, D, and so on, credit for the details that they may determine and fix, but it is not an easy thing to do. If that could be done it would relieve those who do not have a sufficient number of coöperating students to enable them rapidly to work out the large amount of requisite detail, from such detail work, and would permit them freely and without the restraining thought of not having completed that other work, to engage in new work in which they could use their creative and constructive ability to better advantage.

POOLING MEN, MINDS, AND MATERIALS

But, to take this subject out of the field of clashing priority and similar claims, let us consider another phase. There are gaps a-plenty in our knowledge of theoretically foreseeable preparations, inorganic and organic alike. Why not have these gaps charted and the work of filling them in by our colleges and universities coördinated, directed, and, if need be, *supported* by our Society? To be sure, we would have to feel our way very carefully at first, but the fact that it has not been done is, in this case, no reason why it should not be attempted. Not the smallest good from such a work would be closer acquaintance between our various instructional and investigational laboratories and encouragement to investigation by students, but fields abandoned by their original workers would be kept in mind and further developed when opportunity offered; continued and balanced growth of our store of fact-knowledge would result. Further, there must be any number of reactions for identification and differentiation, modes of separation, and the like, which are awaiting discovery and recording. Can it be that it is impracticable for the laboratories of this country to "pool" their resources in students, instructors, and facilities, and systematically to work out these fact-details? I am convinced that it can be done and I believe that our Society is the proper agency to effect such "mobilizing," to use a war-time expression, of our country's resources in men, minds, and materials. It will not do to say, "it can't be done." It is proportionately not as difficult as the job the founders of our Society tackled in 1876. I am convinced that the AMERICAN CHEMICAL SOCIETY has become so strong and so large that it is under obligation to the country to do everything that can be done once and for all for the benefit of all the chemists of the country. This particular job of getting a line on the unworked and abandoned chemical fields, lining up our country's resources in institutions and personnel, distributing the work to be accomplished, publishing the results, attending to it that the "moppers-up" follow as close on the heels of investigators as circumstances will permit, and keeping the whole work in proper alinement is peculiarly one that our Society should undertake.

GOVERNMENT CONTROL OF CHEMICAL RESEARCH

If we do not do it, it is not unreasonable to expect that our Federal Government will, sooner or later; perhaps that may be a good thing, but I am inclined to think not. If we chemists *cannot* efficiently direct the new growth of chemical knowledge, the Federal Government also probably cannot; if we *will not* then our Government would be perfectly justified in taking a hand, an event already foreshadowed in proposed legislation of the Sixty-fourth Congress. We must be prepared to find that hereafter those governments that are spending large sums on chemical research are going to view the field as a whole and are going to determine in large measure what is to be investigated and to what extent and, further, that they will not be over-communicative on such matters as may affect national interests, external or internal. In that event, our country will be disadvantaged. On the other hand, if we so order our affairs that our resources are "pooled" or "integrated," as the latest stylish legal expression has it, and our efforts are directed as a unit and the other countries do not, we will not be at any disadvantage at any rate. The choice, therefore, as I see it is: if we do we will surely *not* be hurt; if we do not, we *may* be hurt. The answer is not in doubt: The Boards of Editors of our "Journal," of our "Chemical Abstracts," and of our "Journal of Industrial and Engineering Chemistry," will serve as an excellent starting point. The final answer lies with us, as members, and with no one else.

AMERICAN HANDBOOKS ESSENTIAL

In 1801 seven of the European languages were spoken by 161,800,000 people. Arranged in the order of the size of their percentage participation, these languages are:

French	19.4
Russian	19.0
German	18.7
Spanish	16.2
English	12.7
Italian	9.3
Portuguese	4.7

In 1911, 585,000,000 people spoke these seven languages; arranged in the order of their percentage participation they are:

English	27.3
German	22.2
Russian	17.1
French	11.9
Italian	8.6
Spanish	8.6
Portuguese	4.3

If now we divide the 1911 percentages by the 1801 percentages, we will get the "growth-rate" for each of these seven European languages; the result is

	Per cent
English	215
German	119
Russian	90
French	61
Italian	92
Spanish	54
Portuguese	91

That is, English and German were the only languages that really grew and English grew 181 per cent as fast as German.

To-day our Society publishes three chemical journals, each in its field the equal of anything published in any language; this was not true 50 years ago nor even 30 years ago. This progress is highly gratifying and augurs well for the future.

But how about those storehouses of the sum total of our chemical fact-knowledge and references to the original sources which are the indispensable tools for research? Has not the time come when for very good and practical reasons, we should have our own handbooks? Why should we be compelled to go to Beilstein for fundamental information in organic chemistry, to Gmelin-Kraut for inorganic, and to Stohmann and Kerl for industrial information? Or to Morely and Muir of England or Thorpe of England? Or to Wurtz of France or Fremy of France? We have made ourselves independent of the *Centralblatt;* why can we not go the whole length? Why should not the leading publications of this kind be in the world's leading and most rapidly growing language? It is clear from European experience that the only way to keep publications of this sort up to date is by putting them under the control of organizations like our Society, which provide continuous editorship and can expand it if need be, and we all know such need. These are only a few of the things that can be done once and for all for the benefit of all American chemists and I earnestly propose that the AMERICAN CHEMICAL SOCIETY do them. Of course, we cannot hope to do all these things or substitutes for them at once, but if we members will set down in black and white all the things we are convinced our Society should do and keep that list of "Wants" up to date, our responsible officers can plan more wisely than they otherwise could, what things shall be undertaken, and how and to what extent. The initiative lies with us as members and not elsewhere. Without a complete picture of the enterprises to be undertaken our officers cannot as safely proceed as they otherwise could.

If our Society will undertake these new enterprises or some of them, then we will be "advancing chemistry and promoting chemical research" more nearly in the sense our founders had in mind in 1876, than if we refrain from so doing.

IT HAS BEEN DONE BEFORE

The physicians, the medical societies, and the medical colleges of this country about 100 years ago and after almost 3 years of coöperative labor published the first U. S. Pharmacopoeia (which has been revised decennially ever since and latterly in coöperation with pharmacists, pharmaceutical colleges and societies and several of the United States Government services) and have produced a work which for decades has been the premier publication of its kind in the world. It simply cannot be that we chemists cannot do equally well by the fact-material of pure and applied chemistry, inorganic, organic, physical, and theoretical. The procedure involved in effecting these proposals is not at all new for this country; the only novel feature is the materials upon which it is proposed to operate; the critical, painstaking research and sifting inseparable from the Pharmacopoeia would not be so prominent a part of these proposals where close reading and full, accurate recording, based upon systems already in existence or to be created, are the prime essentials. Other like successful coöperative American efforts are, no doubt, known to each of you.

If we undertake the work now under discussion there will still be gaps between revisions during which it might be desirable or even necessary to publish supplemental volumes or independent systematic records of *interim* progress like one or the other of the yearbooks that have been published abroad in the past, or on the general plan of the annual progress reports which, for a short time, our Society published, or of those published by the American Pharmaceutical Association for so many years.

OUR JOURNALS AND OUR GOVERNMENT

There is probably no government that is so lavish in publishing, in good readable form, matter from all parts of the world for the benefit of its citizens as the Government of the United States. It is probably true that there is no people that is so indifferent to the efforts of its Government to enlighten it as the people of the United States and that includes us chemists. Apart from a very limited number of our trade publications, our chemical journals have not made any sustained or systematic effort to go through the valuable material so made accessible, *digest* it for their respective readers so that we could with any degree of confidence go to the volume for any one year and find, for example, the important features of the world's and our own development along lines of chemical industry and its specific trends and particularly the extent and nature of our dependence upon foreign countries in this regard.

It took this war to wake us up to this matter and our Directors have recently set aside a fund to enable *The Journal of Industrial and Engineering Chemistry* to try to supply that feature, and our first efforts in that direction are to be found in its September 1918 issue. To be sure, this is a new venture and it would be unreasonable to expect that we had scored a "bull's-eye." We are doing the best we can in this, to us, new field; we are feeling our way; you may want to call it "groping" and perhaps you are right. If any of our members have suggestions for betterment they can rest assured that those suggestions will be welcomed by those who have charge of that field. This work is couched in modes of expression and proceeds from points of view that are unfamiliar to most of us; to grasp its message in all its bearings we will be compelled, in effect, to acquire a new language and a new mode of thought. But that is *our* job.

If and when we get our bearings in this branch of Government publications, we will try to extend our work to other suitable branches. It is not too much to hope that in the course of a few years we will have developed this work to such an extent that THIS JOURNAL will annually contain a bird's-eye view of international trade and production, by countries, of chemicals, chemical products, and materials of and for chemical industry practically the world over. There is so very much room for varied elucidative presentation and treatment of matters of this kind that it is earnestly to be hoped that other chemical publications in this country will enter this field each with an eye to the main requirements and viewpoints of its own readers. The more angles we can get from which to view these matters the better for our country and our profession. Among the benefits of this work that I look forward to is not only that of giving us of the present day a bird's-eye view of the chemical industry of the world and more particularly of this country, that is, a view of the thing as a whole, but further, the opportunity it will afford for the oncoming chemists of to-morrow gradually to absorb this viewpoint by specific instruction or otherwise on their way through college or other courses of learning with the result that when they take their places in our profession and our business, comprehensive view and understanding of *their* function in the industrial and economic fabric as a whole will come almost as second nature to them.

The proposals I have so far made call primarily for no extraordinary help from our Federal Government, though it is no doubt true that as we progress in those fields we will be able to make practical and practicable suggestions for betterment or expansion of such Governmental publications and activities.

OUR CHEMICAL DEPENDENCE

There are, however, matters in which special Governmental work is necessary. As an example, take the matter of the nature and extent of our dependence on foreign countries for chemicals, chemical products, and materials of and for chemical industry. The material published prior to 1914 was not adapted to giving effective answer to that question. There was not enough detail. The first step in this direction was taken when the Bureau of Foreign and Domestic Commerce late in 1916, under the direction of Dr. Thomas H. Norton, published what has since come to be known in general usage as the "Norton Dye Census." Early in 1917, as the direct result of a suggestion made by Dr. Norton in THIS JOURNAL, arrangements were initiated by our Society with the Bureau of Foreign and Domestic Commerce for similar treatment of imports in 1913–14 of all chemicals, chemical products, and products of and for chemical industry other than dyes, and along the general and composite lines followed in a number of foreign countries and our own country. It took considerably over a year to get all those details straightened out and then it took several months to locate a chemist to supervise the work and then some considerable time to get the necessary invoices and working staff together. But all that, happily, is now behind us and we can look forward to a list of about 4000 items for which the Bureau of Foreign and Domestic Commerce will give us the amounts and values of each item and the countries of origin of our imports for that period, the last peace-year before the war. Now that we are practically "out of the woods" on this phase of the work, it seems incredible that we should have had to spend so much time getting where we now are. The reason is *not* Government "red-tape"—not by any means. Very little of that was encountered. The answer is not simple: in the first place it took a long time to analyze the problem into its elements because we chemists did not know exactly what we wanted and of course the Government officials could not guess what we wanted. I haunted many offices in Washington and in New York trying to find out what we needed and to get it into workable shape. In the second place, when we got things boiled down the only available way looked to be such a tremendously rocky road that we spent quite some time looking for "short-cuts" but to no use. There was nothing for it but to arrange with the Treasury Department to have each of the approximately 100 ports of entry segregate from a total of over 500,000 invoices those invoices containing the desired material. To pick out this material from Table 9 of the Bureau of Foreign and Domestic Commerce did not take long, once I had made up my mind that I could not get any substantial help in that direction from the membership-at-large of our Society, although certain few Sections did give me great help. I am perfectly fair when I say that the greatest single cause of delay was due to my attempts to hear from our membership, an effort of great magnitude consuming practically eight months. The reason behind that is no doubt our own inexperience in these matters, and I am very sure that it was not due to unwillingness in any degree. However, that is behind us. When that publication appears, as I hope it may in February 1919, I am sure that the Committee on Import Statistics of our Society appointed last month at our Cleveland meeting will have the benefit of every constructive criticism our membership can make. It is too much to expect that our first effort is perfect, but we do hope for "better luck" next time.

This publication, then, in connection with the Norton Dye Census, will be the best information we can get as to the nature, extent, and scope of our chemical dependence upon foreign countries in 1914. Excepting dyes for the moment, which seem to need no further help from our Society, and turning to the other materials, there is one thing that can be done once and for all for American chemists and which should be done and is being done by the AMERICAN CHEMICAL SOCIETY; that is, to translate all manufactured and semi-manufactured products into needful raw materials and their amounts and to classify these as of mineral, animal, or vegetable origin as well as that can be done.

Unless present tentative plans go wrong the Geological Survey and the Department of Agriculture will tell us in suitable publications where those raw materials come from and which of them can be (and perhaps those which ultimately shall be) obtained in the United States, the object of these being to enable us more speedily and more certainly than otherwise to give full force and effect to our Declaration of Chemical Independence towards which we now have such magnificent results to our credit, and whose advantages we should never relinquish but, on the contrary, should unremittingly protect and energetically develop. I hope that when we similarly record the imports for the first peace-year there will be only 2000 items of imports with big reductions each succeeding year until we have brought our chemical dependence to its irreducible minimum. In order that this result may be further hastened the Tariff Commission may tell us in a suitable publication about the industrial uses of each of these entries.

PROMPT SPECIFIC RESPONSE ESSENTIAL

I have dwelt upon this particular enterprise of our Society at this length not only because it is important as such but also because it shows to what extent a coöperative effort can be blocked through oversight. If more of our Sections than did had notified me promptly that they could not be of service, the work would have been pushed ahead faster in some other direction; but, without seeming arbitrary or high-handed, I could not, in fairness, do otherwise than I did, and I therefore hope that in all future coöperative efforts Sections will understand, and act accordingly, that time limits set must be observed and that before the expiration of that time limit they will definitely express themselves either by giving help or by stating that they need not be waited for, as one Section did to my great comfort. Then those who have to do our work know where they stand and can act accordingly.

With this piece of work, the result of coöperation between at least six Government Bureaus, Departments, or Commissions and our Society, completed, it is not too much to expect that in the future when we will have time to look more closely into the status and possibilities for development of our industries or the betterment of our national research, educational, or other facilities, ways and means of further effective coöperation with Government agencies, Federal or otherwise, will readily be found.

DUTY-FREE CHEMICALS AND APPARATUS

If the reports, spread both by word of mouth and through the press, to the effect that our college and other chemical laboratories have been greatly hampered since the beginning of the war for lack of certain supplies, both apparatus and chemicals, which formerly came to us from abroad have actual foundation in fact, should we not carefully study that question, come to our conclusion as to the remedy, if any, and forcefully present it in such quarters as may be needful to prevent recurrence? Have we not been too complaisant, both in college and out, as to this dependence upon foreign supply sources? Have we not perhaps too actively helped along the idea that foreign laboratory chemicals, foreign filter paper, foreign test tubes, foreign microscopes, foreign porcelain, foreign glassware, and foreign-almost-everything were the real and only things to use? Have we really encouraged domestic makers of related materials to supply these things from domestic sources and manufacture? What percentage of our laboratories in 1913 were of all-American equipment? Have not our colleges contributed a great deal to that state of affairs by using foreign-made goods so extensively in their equipment of those laboratories where most of us received our introduction to materials of this kind? I presume we will all agree that it is of vital national importance that our colleges, universities, and the like be kept at all times at top-notch ability and that measures should be taken to prevent their being crippled at any time. Would it help matters any to abolish our practice of many years' standing; namely, duty-free importation of materials of these kinds for scientific, philosophical, and educational purposes? Perhaps not, but should we not know what our opinion on that point is and should we not now and thoroughly go into it again with the events of the past four years clearly in mind? I will not attempt to give a categorical answer, but will merely ask: If it be proper to tax dyes to the end that we may have a domestic dye industry for the ultimate purpose that large domestic dependent industrial interests may never again be placed in jeopardy, may it not also be proper to tax foreign-made educational and scientific materials to the end that these be made here and for the ultimate purpose that our educational and scientific undertakings dependent thereon may never again be placed in jeopardy? This is a question that requires a great deal of thought and one that cannot be settled off-hand; furthermore, it is a question that may require Federal legislative or other action.

CHEMICAL COMMERCIAL AGENTS

If chemistry and chemical industry be really so essential to national welfare as they are now quite generally accepted as being, should there not be more and effective chemical talent embraced in our foreign consular and similar services than there has been? Should not the AMERICAN CHEMICAL SOCIETY get at the facts, form an opinion, and be prepared to express and follow up that opinion? This may involve added Federal administrative action.

These problems are some of the very many that have been in my mind in a more or less general way and are probably fairly typical of all the rest. But there is just one other big and very handsome thing I should like to see done, and I believe the AMERICAN CHEMICAL SOCIETY really ought to do it. It is not truly a war measure, although its utilitarian side was made more readily discernible by the war. It has considerable utilitarian or sentimental possibilities, as you prefer, through the encouragement the beginner or even an "old timer" in chemistry can get from it when things look very "blue" and the world is "all wrong," quite apart from the new ideas that it may help engender.

AMERICA'S CONTRIBUTION TO CHEMISTRY

What I have in mind is that the contribution of America's chemists to the science and industry of chemistry is not as well known as it should be nor is it a matter that could be readily ascertained, at any rate not before 1914. Professor Edgar F. Smith, by his books "Chemistry in America" (published in 1914) and "The Life of Robert Hare" (published in 1917) has most auspiciously inaugurated the work of worthily presenting the labors and triumphs of America's chemists. Could the Fiftieth Anniversary of the AMERICAN CHEMICAL SOCIETY, which comes in 1926, be more fittingly marked and celebrated than by a Jubilee Volume, which contains as compact and complete an account as could then be made of what American chemists have done? From 1768, the date of the earliest known American chemical research, to 1926 makes a span of 158 years. Just think of the tradition, concrete and tangible, crammed to the bursting point with the triumphs and trials of *Americans*, that would be contained in such a volume. Could any one appraise in dollars and cents or otherwise the value of the stimulation to and the enthusiasm for more and better work on the part of America's then chemists, from beginner to old-timer, that such a volume would create? Could we give the Nation a better or more dependable means of appraising the value of chemistry in its affairs? Incorrect knowledge of national achievements and capabilities is a national weakness; correct knowledge is a national strength.

I know that our Society has many burdens to face in the near future, but could we not find time and opportunity for this work also?

OUR MEMBERS IN THE SERVICE

It may safely be taken for granted that those of our members in Service, both at home and abroad, are acquiring new points of view as to what the future course of action of America's chemists should be and that they are formulating more or less definite lines of action for the AMERICAN CHEMICAL SOCIETY. When they come triumphantly home they will expect to find our Society prepared to receive, consider, and to act upon their suggestions. No doubt, at meetings of our newest Section, "for the entire territory of France," this subject will be threshed out more or less formally and conclusively. Should we not then be able to match their plans with something we have planned so that we can compare the two programs and act upon the result with the least delay? Would any other course be fair to them?

CONCLUSION

I am fully aware that in proposing pre-peace preparedness a task of very great dimensions is being opened up. But can we, in good conscience, do less? Our faces are set toward a future filled with perplexing problems; much effort will have to be put forth, not all of it can succeed. Many or even all of my suggestions may be impracticable or impractical, my present view to the contrary notwithstanding; that is something we must each and all individually be prepared to face; that should not and must not, in these extraordinary times, deter any of us from making all suggestions that to us seem proper. An imperfect suggestion may well contain the germ of a valuable plan. Neither personal pride nor fear of chagrin must in these times make us shrink from contributing whatever we can; fear of personal failure must resolutely be put to one side. We must accustom ourselves to "thinking out loud;" not all thoughts bear fruit, but that is no reason whatever why we should not now "think out loud."

25 BROAD STREET
NEW YORK CITY

CHEMICAL MARKETS IN THE UNION OF SOUTH AFRICA

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

The Union of South Africa is a self-governing British dominion comprising the Cape, Natal, Orange Free State, and Transvaal provinces, the total area of which is 473,075 sq. mi. with a population of 5,973,394, of which 1,276,242 are whites. Mining and agriculture are the chief industries, but the output of gold and diamonds easily exceeds in value all other products. The principal mineral products in 1914 were gold, $173,560,000; diamonds, $26,703,000; coal, $10,847,000; copper, $3,369,000; tin, $1,515,000.

Manufacturing is still in a backward state despite the war stimulation and recent earnest discussion of plans for promoting industrial development. The manufacture of wattle-bark extract for export, in place of the bark formerly taken largely by Germany, is a war industry, and there has also been a marked increase in sugar production. The diamond and ostrich-feather industries, on the other hand, have been very adversely affected by the war. As a whole, the Union has had its share of war prosperity, the fly in the ointment being the high prices of necessities, which, as in other countries, have counteracted to a large extent the high wages received by the poorer classes.

The per capita purchases of heavy and fine chemicals are high, so that the Union is a more attractive field for the sale of such products than many of the more thickly settled countries that receive more attention from our manufacturers. The principal difficulty lies in the fact that the mother country does the bulk of the business and in all likelihood will continue to do so. American products are well and favorably known, however, and a steady expansion of the business should be possible, especially in view of the fact that there are certain German lines to replace, although it should be recognized at the start that this is one of the markets that Teuton chemical products did not dominate.

An idea of the extent of the market for chemicals and allied materials and products can be gained from the following table, which shows imports by principal classes for the calendar years 1914, 1916 and 1917. It should be borne in mind that there was a dislocation of trade during the latter part of 1914, wherefore that year should not be considered normal. The total imports of all classes of goods into the Union in 1914 fell about 20 per cent below the total for 1913; in value, the imports for 1916 correspond very nearly to normal.

SUMMARY OF IMPORTS OF CHEMICALS AND ALLIED LINES

CLASSES	1914	1916	1917
Chemicals	$6,226,000	$7,566,000	$7,392,000
Drugs, medicines, perfumery, etc.	2,089,000	2,760,000	2,595,000
Dyes and tanning materials	28,000	132,000	137,000
Explosives	1,189,000	1,646,000	1,201,000
Fertilizers	880,000	617,000	219,000
Oils, fats, and waxes	5,215,000	8,216,000	9,614,000
Paints, varnishes, etc	831,000	1,304,000	951,000
Metals and miscellaneous materials	1,527,000	3,041,000	2,260,000
Miscellaneous products	5,264,000	6,754,000	6,169,000
TOTAL	23,249,000	32,036,000	30,538,000

An idea of the relative importance of the principal chemicals and allied products that enter the import trade may be gained from the following arrangement, in which the articles are divided into two convenient classes and arranged according to their importance in 1917, only such lines being included as exceeded $400,000 in value during one or more of the three years considered. It will be seen that the three most important items under the heading "Chemicals, drugs, etc." have to do with mining, the principal industry of the country; that is, they are materials for the manufacture of explosives for breaking rock, or materials for the reduction of the ore. Large quantities of explosives, however, are now being manufactured for war purposes. These classes are followed by the finer chemicals included under the headings perfumery, medicines, and pharmaceutical supplies, the per capita consumption of which, considering the limited white population, is rather high. The only important item imported for agricultural purposes is superphosphates, the last on the list. The most imposing totals for the allied products are mineral oils, in which the United States has a large share, paper, paraffin wax, and vegetable oils.

RELATIVE IMPORTANCE OF VARIOUS LINES IMPORTED

ARTICLES	1914	1916	1917
CHEMICALS, DRUGS, ETC.:			
Glycerin	$2,101,000	$1,826,000	$1,910,000
Industrial nitrates	1,073,000	1,357,000	1,829,000
Sodium cyanide	1,812,000	2,167,000	1,703,000
Perfumery	398,000	668,000	677,000
Medicinal preparations	514,000	648,000	595,000
Pharmaceutical supplies	722,000	620,000	375,000
Superphosphates	429,000	437,000	148,000
ALLIED MATERIALS AND PRODUCTS:			
Mineral oil	3,196,000	4,105,000	5,565,000
Paper	1,267,000	3,031,000	2,595,000
Paraffin wax	626,000	1,461,000	1,812,000
Vegetable oil	872,000	1,608,000	1,295,000
Zinc	683,000	1,898,000	1,191,000
Glass	903,000	1,651,000	974,000
Sugar	1,315,000	245,000	821,000
Fuse	463,000	888,000	752,000
Detonators	201,000	568,000	302,000

CHEMICALS

The following table shows the extent to which the various articles that may be classed as chemicals are imported into the Union of South Africa and the extent to which the principal competing countries share in the market. The glycerin is imported chiefly from the mother country, but there has recently been an acute shortage and great efforts are being made to stimulate the domestic output and at the same time to produce mine explosives that do not require glycerin.

The sodium cyanide was supplied by Great Britain and Germany before the war and now comes exclusively from the former country. The United States has no share in the trade. The sodium nitrate is imported directly from Chile.

IMPORTS OF CHEMICALS

ARTICLES	1914	1916	1917
Acids:			
Acetic	$ 1,290	$ 5,086	$ 2,370
United Kingdom	1,192	3,854	1,630
United States	19	895	419
Nitric	1,698	2,866	2,837
United Kingdom	1,552	2,253	2,453
United States	.....	613	384
Sulfuric	6,823	3,489	3,815
United Kingdom	6,546	2,711	2,793
United States	.....	779	1,022
Tannic	550	3,708	2,331
Germany	448	.....	.....
United Kingdom	.....	297	.....
United States	.....	3,236	2,331
Tartaric	25,190	41,794	39,024
Germany	12,818	.....	.....
Italy	706	24,284	18,396
United Kingdom	10,628	14,634	17,841
United States	.....	934	268
Ammonia:			
For ice-making	25,856	31,439	43,638
Australia	10,701	10,692	15,461
United Kingdom	7,680	9,227	16,478
United States	7,266	11,519	11,699
Carbonate	3,460	7,583	8,186
United Kingdom	3,460	7,568	8,186
United States	.....	15	.....
Nitrate	34,431	42,923	574
Belgium	14,800	.....	.....
Germany	6,536	.....	.....
Norway	11,879	42,923	.....
United States	.....	.....	.....
Borax	60,850	120,553	57,965
United Kingdom	60,019	120,081	57,274
United States	550	443	15
Calcium carbide	256,065	257,564	140,326
Canada	111,161	149,071	111,477
Norway	105,273	64,924	14,809
United States	12,994	14,590	2,304
Carbonic acid gas	6,833	5,646	4,989
Germany	4,794	34	.....
United Kingdom	1,187	4,375	4,989
United States	.....	54	.....
Chloride of lime	11,290	31,625	19,675
United Kingdom	11,144	28,552	18,566
United States	5	2,068	258
Creosote	2,769	8,444	2,384
United Kingdom	2,769	8,424	2,384
United States	.....	20	.....
Disinfectants and germicides	226,560	393,948	396,090
United Kingdom	213,464	363,659	363,216
United States	4,531	20,220	24,464
Glycerin, industrial:			
Crude	2,100,927	486,188	598,526
United Kingdom	1,177,173	409,531	514,424
United States	258	.....	711
Other	(*a*)	1,340,205	1,311,128
United Kingdom	.....	1,337,275	1,255,465
United States	.....	2,930	19,282
Nitrates for manufacturing purposes	1,073,117	1,356,980	1,829,357
Chile	1,044,682	1,348,751	1,746,626
United States	.....	92	.....
Potash:			
Cyanide	9,184	1,343	184,670
United Kingdom	3,299	1,265	184,670
United States	.....	.....	.....
Saltpeter	6,575	15,588	15,860
United Kingdom	3,991	15,364	14,463
United States	.....	15	1,397
Compounds of, n. o. d[1]	69,815	117,195	67,411
United Kingdom	16,878	85,271	46,188
Germany	16,328	1,849	.....
United States	633	8,123	11,281
Sheep and cattle dip	215,250	321,642	259,414
United Kingdom	192,252	264,684	186,718
United States	18,284	56,851	62,685
Soda:			
Carbonate	.....	24,878	45,896
United Kingdom	.....	24,863	42,480
United States	.....	15	1,976
Caustic	107,005	346,476	248,817
United Kingdom	101,778	268,772	160,045
United States	4,701	76,896	124,743
Cyanide	1,812,431	2,167,287	1,703,241
Germany	739,990	7,548	.....
United Kingdom	1,064,153	2,159,739	1,703,241
United States	.....	.....	.....
Compounds of, n. o. d[1]	69,815	78,935	49,239
United Kingdom	63,157	70,730	46,013
United States	5	6,994	1,796
Sulfur:			
Rock, including iron pyrites	58,340	205,897	310,079
Italy	55,883	80,307	29,569
Japan	.....	.....	89,787
Spain	.....	80,755	37,229
United States	2,414	44,836	152,025
Flowers of	38,874	146,701	43,677
Italy	22,639	124,807	7,597
Japan	.....	5	10,166
United Kingdom	13,582	15,948	745
United States	1,436	5,538	25,160

(*a*) No classification of glycerin attempted in 1914.

[1] Not otherwise distinguished.

Sheep and cattle dips, germicides, and disinfectants together form a considerable total, of which Great Britain has almost a monopoly. According to the Weekly Bulletin of the Canadian Department of Trade and Commerce, there will be a steadily increasing demand for ammonia for ice-making, as the refrigerating industry is bound to grow.

To those who have pondered the German success in other countries, the insignificant part that German chemicals have played in this market, as shown in the preceding table, will come as a surprise.

DRUGS, MEDICINES, PHARMACEUTICAL SUPPLIES

In medicinal supplies and perfumeries the United States has a very fair share of the South African trade, the United Kingdom alone having a larger business, and Germany being nowhere. In pharmaceutical supplies English goods predominate, although American lines are sold in some quantity. German manufacturers did twice as much business as their American competitors in this line in 1914. In estimating the effect the war has had on the trade, the rise in prices should be kept in mind when comparing the import values for the different years. The South African market for drugs, medicines, etc., can be estimated from the following table:

Imports of Drugs, Medicines, Etc.

Articles	1914	1916	1917
Bacteriological products, including vaccine virus, etc.	$22,765	$17,938	$14,400
United Kingdom	14,390	10,390	5,373
United States	7,154	6,780	8,522
Bromine, litharge, and manganese dioxide	25,992	65,051	24,338
United Kingdom	23,534	62,588	19,228
United States	1,061	822	73
Magnesium sulfate	10,147	29,133	19,043
United Kingdom	9,617	23,982	16,449
United States	...	243	1,484
Medicinal preparations:			
Spirituous	70,827	127,108	108,596
United Kingdom	39,837	82,804	68,477
United States	25,832	41,584	36,416
Non-spirituous	442,897	520,721	486,456
United Kingdom	339,380	417,707	362,326
United States	77,023	83,724	98,070
Opium	2,934	6,818	7,660
Turkish Empire	2,389	3,353	560
United States	...	...	...
Perfumery and perfumed spirits:			
Perfumery	311,442	527,178	517,411
United Kingdom	149,873	237,733	227,815
United States	111,204	205,298	232,118
Perfumed spirits	84,001	140,476	159,538
Germany	26,231	...	...
United Kingdom	46,310	123,712	147,304
United States	988	1,981	3,076
Pharmaceutical supplies	721,541	620,216	375,256
Germany	98,498	759	73
United Kingdom	515,966	460,955	266,762
United States	42,304	61,337	42,188
Saccharine	910	3,319	1,518
United Kingdom	857	3,314	1,056
United States	53	5	24
Spirits, non-potable:			
Alcohol	117	526	229
Methylated	224	117	5
Other plain spirits	...	...	555
Tartar, cream of	36,100	49,088	48,105
France	22,225	28,698	32,683
Germany	7,947	...	...
United Kingdom	5,792	3,051	7,354
United States	...	12,594	4,102
Tinctures	1,475	3,908	1,178
United Kingdom	1,012	3,076	535
United States	297	822	642
All other[1]	358,613	648,501	831,568
Germany	73,991	1,382	1,426
United Kingdom	233,565	517,718	576,748
United States	23,758	73,032	109,462

[1] Includes all other drugs, chemicals, and pharmaceutical products.

DYES AND TANNING MATERIALS

The items included under this head in the following table are those shown in the official statistics. The only articles of any importance are evidently included under the "All other" head, which itself is comparatively insignificant:

Imports of Dyes and Tanning Materials

Articles	1914	1916	1917
Bark	$ 107	$ 9,179	$ 3,275
Cutch	307	944	1,981
Gambier	866	886	1,236
Logwood	170	788	3,854
Myrobalans	331	7,057	4,536
Sumac	428	1,178	5,169
All other, n. o. d.	25,394	111,477	116,981
United Kingdom	10,273	60,121	57,338
United States	5,359	42,971	46,403

FERTILIZERS

The only important fertilizer imported into the Union of South Africa is superphosphate, the bulk of which came from the Netherlands before the war. In 1916 England was the most important source of supply, with Japan, a newcomer, second. In 1917 Japan had the field to herself, although unable to satisfy demands. Details of the fertilizer trade are shown in the following table:

Imports of Fertilizers

Articles	1914	1916	1917
Ammonium sulfate	$11,719	$ 3,859	$ 3,903
Basic slag	67,090	100,318	12,191
United Kingdom	29,374	100,318	12,191
United States	...	...	...
Bone manures	89,023	4,404	10,069
India	24,498	...	8,527
United Kingdom	25,691	4,205	297
United States	5	...	...
Guano	24,171	448	7,140
Nitrate of soda	1,105	73	...
Phosphates, raw	5,767	...	...
Potash	30,080	...	...
Superphosphates	428,753	437,133	148,063
Japan	...	139,352	130,914
Netherlands	290,633	...	...
United Kingdom	87,986	289,187	17,135
United States	...	8,595	15
All other	222,604	70,584	38,013
Netherlands	78,341	...	...
United Kingdom	138,510	60,077	12,395
United States	...	3,509	17,953

COLORS, PAINTS, AND PAINTERS' GOODS

In this line the United States has a monopoly of the trade in turpentine and a goodly share of the business in water paints, distempers, and ocher. The mother country dominates the important "All other" class. Details of the trade are as follows:

Imports of Paints, Colors, and Painters' Goods

Articles	1914	1916	1917
Ocher	$35,998	$47,897	$44,909
United Kingdom	35,852	47,858	44,826
United States	...	...	...
Turpentine and substitutes	71,654	93,632	88,225
United States	69,498	87,627	83,281
Varnish	107,535	184,811	128,787
United Kingdom	93,569	163,758	110,664
United States	9,412	17,792	15,817
Water paints and distempers	59,673	81,582	57,065
United Kingdom	24,756	30,927	23,753
United States	33,963	48,147	31,481
All other kinds	556,075	895,601	632,193
United Kingdom	484,689	819,922	495,770
United States	43,005	45,127	95,287

EXPLOSIVES

A glance at the next table will show that the mining industry has not depended upon foreign manufacturers to any great extent for explosives, although reliance seems to be placed upon outside sources for such accessories as fuses and detonators. As already mentioned, the shortage of glycerin has worked a hardship on the domestic explosive industry, but the manufacturers have been producing an explosive called sengite to take the place of gelignite, the new preparation not calling for glycerin. Nevertheless the Chairman of the Scientific and Technical Committee, in a report published by the Department of Mines and Industries and dated January 1918, states:

> The mining industry is dependent upon an adequate supply of explosives, in the manufacture of which glycerin forms an

essential ingredient, and, unless the requisite quantity of this latter chemical is obtained, the supply of gold to the United Kingdom, the revenue of the Union, the livelihood of many persons directly or indirectly dependent upon the mining industry, and the market for South African produce, must be seriously curtailed.

IMPORTS OF EXPLOSIVES

ARTICLES	1914	1916	1917
Blasting compounds:			
Collodion and guncotton	$245,247	$ ...	$ ...
Germany	65,173	...	...
United Kingdom	180,074	...	...
United States	....	...	...
Dynamite and other compounds	58,739	7,587	...
United Kingdom	58,695	7,582	...
United States	....	...	...
Caps, percussion	633	336	638
Cartridges, loaded	183,560	155,208	125,045
Germany	26,508	83	...
United Kingdom	144,501	102,499	62,111
United States	6,303	52,339	62,311
Detonators	200,670	568,212	301,621
United Kingdom	195,580	279,849	243,510
United States	....	288,365	58,111
Fuse	463,116	887,981	752,346
Germany	75,495	...	...
United Kingdom	379,772	570,121	718,695
United States	1,956	308,074	33,409
Gunpowder, including powder contained in cartridges	37,263	26,956	21,052
United Kingdom	30,250	21,549	13,870
United States	676	5,183	6,419

OILS, FATS, AND WAXES

Mineral oils form by far the largest item in this group of imports, and the United States dominates the trade, especially in lubricating and illuminating oils. The Dutch East Indies are a formidable competitor in the trade in the lighter distillates. American producers have some share in the edible-oil trade, but considering the vegetable-oil business as a whole the United States is not an important factor. American exporters had about half the business in paraffin wax before the war, but are second now to the exporters of India, although sales have increased greatly in value. The imports of "anti-friction grease" were divided rather evenly between Great Britain and the United States before the war, but our exporters have increased their share since hostilities started. Details of the imports of these lines are shown in the table that follows:

IMPORTS OF OILS, FATS, AND WAXES

ARTICLES	1914	1916	1917
Oils, animal:			
Fish	$ 2,005	$ 9,154	$ 9,548
Lard	4,950	9,825	7,320
Whale	38,655	131	83
Other animal	2,205	3,796	2,633
Oils, mineral:			
Lubricating	726,637	926,343	1,110,326
United States	627,667	844,937	1,041,431
Motor spirit, including benzene and naphtha	1,164,301	1,760,413	2,661,328
Dutch East India Islands	557,837	869,507	1,055,807
United States	600,872	884,613	1,601,566
Paraffin[1]	1,284,581	1,225,629	1,485,383
United States	1,283,170	1,225,369	1,485,383
Other mineral	20,902	192,831	308,123
Oils, vegetable:			
Castor	80,808	130,364	205,541
India	26,572	39,268	106,820
United Kingdom	48,787	86,921	96,858
United States	774	190	200
Cocoa butter	10,843	8,838	6,122
United Kingdom	5,276	5,154	4,759
United States	.....	3,679	1,178
Coconut	83,524	165,991	145,285
Australia	29,068	.....	.....
India	25,253	27,078	38,353
Mauritius	16,576	58,366	24,703
Zanzibar	.....	29,311	43,112
United States	83	.....	5,558
Colza and rape	4,755	15,023	13,310
Cottonseed, industrial	99,462	105,146	90,833
China	11,824	77,684	81,655
United Kingdom	77,986	19,505	117
United States	2,136	6,696	9,062
Linseed	189,828	323,501	254,031
United Kingdom	189,161	320,722	208,753
United States	2,136	6,696	9,719
Oils, vegetable (*concluded*):			
Palm and palm kernel	$ 76,755	$ 431,284	$ 125,546
British West Africa	13,128	347,167	297
Nigeria	62,393	76,030	120,787
United States	.....	.....	.....
Salad:			
Cottonseed	149,606	150,501	83,719
United States	123,819	133,927	79,708
Other salad oils	126,738	261,385	315,675
India	3,037	75,056	137,566
United Kingdom	43,745	66,448	77,032
United States	48,865	82,658	51,298
Other vegetable	50,077	16,313	54,715
Anti-friction grease	214,953	331,764	315,992
United Kingdom	113,005	132,890	124,539
United States	97,427	198,529	191,186
Margarine and other butter substitutes	107,521	152,268	32,980
Netherlands	52,592	65,820	5,159
United Kingdom	50,378	84,069	22,259
United States	1,509	652	2,623
Wax:			
Beeswax	1,976	7,193	10,030
Paraffin	626,163	1,461,118	1,811,671
India	148,404	259,531	914,547
United Kingdom	122,310	66,326	93,428
United States	317,608	1,113,922	770,620
Stearin	148,219	118,227	145,266
United Kingdom	61,970	110,454	134,340
United States	9,052	7,626	10,925
Oil-bearing materials:			
Copra	.....	253,903	299,937
Zanzibar	.....	196,938	230,176
United States	.....	.....	.....
Palm kernels	.....	76,181	.....
British West Africa	.....	76,181	.....
United States	.....	.....	.....
All other	.....	78,575	118,952

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[1] Kerosene.

MISCELLANEOUS PRODUCTS

The United States has never enjoyed the lion's share of the trade in any of the articles included in this group except baking powder, yet a study of the following table should reveal possibilities for future opportunities that will be well worth while. The demand for some of these lines will grow steadily once the war is over and it is unlikely that certain of the old sources of supply will be relied upon again for some years to come.

IMPORTS OF MISCELLANEOUS PRODUCTS

ARTICLES	1914	1916	1917
Baking powder	$ 228,726	$ 243,174	$ 409,803
United Kingdom	14,429	31,914	15,632
United States	211,372	211,051	394,152
Blacking and shoe polish	241,129	254,941	240,275
United Kingdom	234,872	241,968	226,132
United States	3,796	12,886	13,758
Blue	63,864	70,043	114,636
United Kingdom	63,494	68,550	114,582
United States	.....	151	24
Candles	22,858	10,774	4,628
United Kingdom	19,982	10,186	4,531
United States	433	10	78
Extracts and essences:			
Food	123,576	130,086	68,219
United Kingdom	120,782	125,623	62,520
United States	618	2,526	4,370
Flavoring, spirituous	83,879	110,971	89,145
France	14,829	26,708	28,061
United Kingdom	67,124	83,130	60,627
United States	185	779	268
Flavoring, non-spirituous	9,942	12,556	5,918
United Kingdom	7,889	8,162	2,132
United States	219	419	355
Glass:			
Bottles and jars	499,848	894,356	509,703
Germany	78,443	13,456	1,304
Japan	.....	63,469	61,907
Sweden	75,022	245,656	76,721
United Kingdom	267,468	261,351	284,564
United States	46,860	236,288	57,211
Plate	115,682	182,464	137,245
Belgium	32,523	4,069	151
Canada	80,891	2,847	.....
United Kingdom	.....	160,195	133,966
United States	15	15,364	3,056
Window	97,287	206,057	142,827
Belgium	44,573	10,798	17,174
United Kingdom	44,388	98,912	90,814
United States	44	85,456	26,275
Glassware, n. o. d.	190,719	368,302	183,964
Belgium	46,870	56,904	18,658
Germany	52,393	900	209
Japan	920	76,803	59,503
United Kingdom	56,106	62,729	48,816
United States	12,994	83,437	40,548
Glue	19,155	50,616	46,870
United Kingdom	12,984	33,559	43,648
United States	1,343	2,861	1,436
Matches	17,048	8,609	3,981
Sweden	15,714	8,098	3,830
United States	5	.....	.....

Imports of Miscellaneous Products (*Concluded*)

Articles	1914	1916	1917
Paper:			
Printing	$ 960,346	$1,903,503	$1,754,617
Canada	288,394	312,634	365,810
Germany	73,295	895	.....
Norway	30,133	116,675	113,200
Sweden	110,898	224,044	382,346
United Kingdom	439,567	996,095	606,142
United States	45,235	213,654	225,095
Wrapping	306,765	1,127,320	840,634
Canada	2,540	288,365	168,113
Germany	35,117	209	.....
Norway	57,070	177,175	50,514
Sweden	110,898	348,101	251,866
United Kingdom	80,847	288,282	278,627
United States	5,290	79,752	50,646
Photographic material[1]	240,177	292,569	295,353
Germany	15,418	122	.....
United Kingdom	132,491	168,434	178,849
United States	87,845	120,383	108,396
Soap:			
Common, brown, etc.	184,467	172,002	130,208
Australia	150,862	77,013	82,293
United Kingdom	7,539	30,211	23,924
United States	28,455	63,834	19,432
Toilet	155,101	263,000	207,011
United Kingdom	102,757	174,284	151,597
United States	39,905	85,203	50,495
Extracts and powders	11,996	26,333	21,408
United Kingdom	11,315	25,895	21,198
United States	428	389	107
Sugar, molasses, etc.:			
Glucose	58,899	69,012	111,930
United States	54,627	67,771	100,664
Golden sirup	312,750	107,443	27,968
United Kingdom	312,493	106,937	24,990
United States	88	165	1,645
Molasses and treacle	3,650	3,158	808
Saccharum	1,197	1,523	545
Sugar	1,314,889	245,495	821,339
Mauritius	588,384	14,999	43,608
Portuguese East Africa	586,170	186,056	724,052
United States	7,898	34,523	49,843

[1] Sensitized goods not stated separately.

MISCELLANEOUS MATERIALS

Zinc is the only item of outstanding importance in this group and it is now imported almost exclusively from the United States. Previous to the war Germany was a serious rival. The extent to which the various items are imported is shown in the following table:

Imports of Miscellaneous Materials

Articles	1914	1916	1918
Metals:			
Copper, bar, ingot, rod	$ 24,747	$ 39,959	$ 23,126
Iron, pig and ingot	20,770	36,903	56,617
Lead, bar, pig, and sheet	80,419	119,190	58,734
Quicksilver	134,817	192,003	188,664
Tin, bar, block, ingot	50,096	81,616	170,688
Zinc, unmanufactured	683,251	1,898,485	1,191,217
Belgium	68,112	.....	.....
Germany	245,086	92	24
United States	340,052	1,810,684	1,079,818
Other Materials:			
Asphalt and bitumen	17,729	14,230	20,863
Cement	340,169	227,475	105,389
Emery	12,195	25,185	23,987
India rubber and gutta-percha	(*a*)	105,720	141,840
Lime	12,502	9,519	1,479
Mica	2,097	2,900	2,599
Pitch	8,210	3,314	4,015
Plumbago	3,528	6,152	4,730
Plaster	5,305	11,422	8,098
Resin and rosin	45,132	129,206	115,653
Tar and substitutes	86,088	137,887	142,224

(*a*) Not stated separately in 1914.

ORIGINAL PAPERS

EXAMINATION OF ORGANIC DEVELOPING AGENTS

By H. T. Clarke

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From the time that the European war cut off the supply of foreign organic chemicals to this country, two distinct activities have been apparent in the photographic developing agent trade; on the one hand, the efforts of manufacturing concerns to produce the most necessary substances, like hydroquinone and salts of *p*-aminophenol, and, on the other, the less commendable manipulations of the purveyors of bogus and adulterated developing agents. For the control of both of these activities chemists are necessary—to check the purity of the genuine products and expose the composition of the false. Moreover, in many cases developing agents are submitted under fancy names and it is necessary to identify the substances they contain.

The work of the analyst thus falls into three classes: the separation and identification of genuine developing agents; the quantitative determination of such substances; and the identification of the materials employed for adulteration or substitution.

The following scheme for the identification of the commoner developing agents is drawn up to meet the first; a few suggestions for quantitative work follow; but owing to the enormous number and variety of adulterants, no attempt can be made to indicate all of the methods employed for their detection and estimation, which in any case are subject to the methods of routine analysis.

QUALITATIVE METHODS

GROUP TESTS

Taking 0.1 g. of sample:

- I—Insoluble in 5 cc. of cold water:
    - *p*-Hydroxylphenyl glycine
- II—Soluble in 5 cc. of ether:
    - Hydroquinone
    - Chlorohydroquinone
    - Catechol
    - Pyrogallol
- III—Soluble in 5 cc. of alcohol:
    - *p*-Aminophenol base
    - *p*-Aminophenol hydrochloride
    - 5-Amino-2-cresol hydrochloride
    - 2,4-Diaminophenol hydrochloride
    - *p*-Dimethylaminophenol oxalate
- III*a*—Insoluble in alcohol:
    - *p*-Aminophenol sulfate
    - 5-Amino-2-cresol sulfate
    - *p*-Methylaminophenol sulfate
    - *p*-Dimethylaminophenol sulfate
    - *o*-Methylaminophenol sulfate
    - *p*-Phenylenediamine hydrochloride

DISTINGUISHING TESTS

(A) Test aqueous solutions with litmus: Neutral or only faintly acid with Group II; Groups III and III*a* give markedly acid solutions (with the exception of pure *p*-aminophenol base). Test aqueous solutions for chlorides, sulfate, oxalate, and other common anions.

(B) Treat 0.1 g. in 1 cc. hot water with one or two drops of 10 per cent sodium carbonate solution, and let mixture stand a few minutes to cool.

GROUP I. *p-Hydroxyphenylglycine*—Dissolves with effervescence; very little change on standing.

GROUP II. *Hydroquinone, Chlorohydroquinone, and Catechol*—No effervescence; solution darkens slowly on standing.

Pyrogallol—No effervescence, solution darkens rapidly on standing.

GROUPS III AND IIIa—All cause effervescence except pure *p-aminophenol* base.

Crystalline precipitates formed on cooling: Salts of *p-aminophenol, 5-amino-2-cresol* and *o-methylaminophenol.*

No precipitate on cooling: Salts of *2,4-diaminophenol, p-methylaminophenol, p-dimethylaminophenol,* and *p-phenylenediamine.*

(C) To 0.1 g. of sample in 2 cc. of water add a few drops of 10 per cent ferric chloride solution.

GROUP I—*p-Hydroxyphenylglycine* gives no color reaction in the cold; odor of quinone on boiling.

GROUP II—*Hydroquinone* gives dark greenish precipitate of quinhydrone in the cold; strong odor of quinone on boiling.

Chlorohydroquinone gives reddish brown coloration in the cold, odor resembling that of quinone on boiling.

Catechol gives a green coloration with one drop of ferric chloride; with excess a nearly black precipitate is formed; no odor is produced on boiling.

Pyrogallol gives intense reddish brown coloration in the cold; no odor on boiling.

GROUPS III AND IIIa—Salts of *p-aminophenol* and *5-amino-2-cresol* give purple colorations in the cold; odors of quinones on boiling; the purple colors are not destroyed.

p-Methylaminophenol sulfate behaves similarly, except that the purple coloration is developed more slowly.

Salts of *p-dimethylaminophenol* give no color in the cold; the solution darkens on boiling, with formation of quinone odor.

With *2,4-diaminophenol hydrochloride* an intense red color is developed in the cold; no odor is produced on boiling.

With *o-methylaminophenol sulfate* a dark purple color is produced, turning to red-brown on standing or more rapidly on warming. No odor is produced on boiling.

With *p-phenylenediamine hydrochloride* a deep green color is developed, followed immediately by a dull purple; on boiling, the color changes to a dull reddish brown, and the odor of quinone is produced.

(D) To 0.1 g. of sample in 1 cc. of water add 2 cc. of 5 per cent silver nitrate solution.

GROUP I—*p-Hydroxyphenylglycine* in suspension causes a black deposit in the cold which, on boiling, instantly becomes light brown, while the liquid rapidly acquires a purple color.

GROUP II—*Hydroquinone* gives a silky white precipitate in the cold; the odor of quinone is developed on boiling.

Chlorohydroquinone scarcely reduces silver nitrate in the cold, but rapidly on boiling.

Catechol slowly reduces the reagent in the cold; no characteristic color or odor developed in boiling.

Pyrogallol causes instant reduction in the cold, giving a brown precipitate; no odor produced on boiling.

GROUPS III AND IIIa—Salts of *p-aminophenol, p-methylaminophenol* and *5-amino-2-cresol* give purple colorations, with quinone-like odors on boiling.

Salts of *p-dimethylaminophenol* give no color in the cold; on boiling, a brownish red color and the odor of quinone are developed.

2,4-Diaminophenol hydrochloride yields an intense red color; no odor on boiling.

o-Methylaminophenol sulfate gives a yellowish brown color in the cold, becoming reddish brown on heating; no odor developed on boiling.

p-Phenylenediamine hydrochloride yields in the cold a transitory pale green color, followed instantly by a deep purple; no color change and no odor on boiling.

SPECIFIC TESTS

Two reactions which should be performed with every developing agent are acetylation and benzoylation.

In acetylation the substance is mixed with about three times its weight of acetic anhydride, together, if the developing agent be a salt of a base, with an equal weight of anhydrous sodium acetate, and the mixture gently boiled for a few instants over a flame. After the mass has cooled, about ten volumes of water are added and the separated solid filtered off and recrystallized from alcohol or similar solvent.

In benzoylation (Schotten-Baumann process) the substance is mixed with about four times its weight of benzoyl chloride, and an excess of 10 per cent caustic soda solution added, whereupon the mixture is vigorously shaken in a stoppered tube, cooling if necessary, and occasionally releasing any excess pressure by opening the stopper. Shaking must be continued until the irritating odor of the benzoyl chloride has disappeared. Care must be taken that an excess of alkali is present at the end of the reaction. The separated solid is then filtered off, washed with water, and recrystallized from acetone or other suitable solvent.

The derivatives thus produced possess characteristic melting points, so that any identification can be definitely established by their aid.

GROUP I—*p-Hydroxyphenylglycine* dissolves readily in dilute sodium carbonate, sodium hydroxide, sodium sulfite, or ammonia; also in dilute mineral acids, but not in dilute acetic acid. When pure it crystallizes in colorless leaflets, melting indistinctly with decomposition above 200°.

GROUP II—The four substances described in this group all form bright yellow, water-soluble compounds with sulfurous acid (or sodium bisulfite and dilute acid).

Hydroquinone crystallizes readily from water in colorless needles melting at 169°. It boils at 285°. The vapor is almost odorless. It is insoluble in benzene. Quinhydrone, precipitated by a cold acid solution of ferric chloride, or of potassium bichromate, melts at 171°. Quinone, formed by the action of an excess of acid bichromate, melts at 116°. The diacetyl derivative melts at 123°; the dibenzoyl derivative melts at 199°.

Chlorohydroquinone is too soluble in water to crystallize from aqueous solution. It dissolves readily in warm benzene. It melts at 106° and boils at 263°. The vapor has a distinct phenolic odor. The diacetyl derivative melts at 99°. Chloroquinone, produced by oxidizing with acid bichromate, melts at 57°.

Catechol forms feathery needles which melt at 104° and boil at 245° and are extremely soluble in water. It is readily soluble in hot benzene, sparingly in cold. It possesses an odor resembling that of pyrogallol. On treatment with bromine in carbon tetrachloride solution, hydrogen bromide is evolved, and a tetrabromo derivative melting at 192° is produced. The diacetyl derivative melts at 63°; the dibenzoyl derivative melts at 84°.

Pyrogallol is extremely soluble in water. It is slightly soluble in hot benzene, almost insoluble in cold. It melts at 133° and boils at 293°. It possesses a peculiar and characteristic odor. Its aqueous solution gives a blue precipitate with ferrous sulfate. The triacetyl derivative melts at 161°; the tribenzoyl derivative melts at 89°.

GROUPS III AND IIIa. *p-Aminophenol and Its Salts*—The free base crystallizes from water in leaflets, melting with decomposition at 184°, soluble in about 100 parts of cold water. It is moderately soluble in hot alcohol, sparingly in ether. The hydrochloride crystallizes in prisms, and is sparingly soluble in concentrated hydrochloric acid. The sulfate, crystallizing in fine needles, is less soluble in cold water than the hydrochloride, but the hydrochloride is precipitated from an aqueous solution of the sulfate on adding concentrated hydrochloric acid. On adding to a cold, slightly acid solution an excess of sodium acetate and then a few drops of benzaldehyde, the pale yellow benzylidene derivative is soon precipitated, which crystallizes from methyl alcohol in needles melting at 183°. The diacetyl derivative melts at 150°; the dibenzoyl derivative melts at 234°.

5-Amino-2-cresol and its salts resemble *p*-aminophenol and its corresponding salts very closely in solubility and chemical behavior. The free base crystallizes from water in flat needles melting with decomposition at 176°. The hydrochloride crystallizes either in needles, or, less frequently, in leaflets. The sulfate crystallizes in fine needles. On oxidation with acid bichromate it yields toluquinone melting at 68°. The benzylidene derivative is markedly less soluble than benzylidene-*p*-aminophenol in methyl alcohol, from which it crystallizes in leaflets melting at 208°. The diacetyl derivative melts at 103°; on gentle hydrolysis with alkali it yields the monoacetyl derivative melting at 179°. The dibenzoyl derivative melts at 194°.

2,4-Diaminophenol is met with only as the hydrochloride. The free base is not precipitated from solution on addition of sodium carbonate; the neutralized solution darkens very rapidly in air. The hydrochloride is sparingly soluble in concentrated hydrochloric acid. Attempts to prepare a benzylidene derivative led to a smeary yellow product. The triacetyl derivative melts at 180°; the tribenzoyl derivative melts at 231°.

p-Methylaminophenol is met with only as the sulfate, which crystallizes in fine needles. The free base is fairly readily soluble in cold water, but is precipitated on neutralizing a cold saturated solution of the sulfate with sodium carbonate; it melts at 85° and is extremely soluble in ether. On allowing a solution in an excess of sodium hydroxide to stand in air, a dark color rapidly develops, accompanied by a characteristic odor not unlike that of a trace of pyridine. On adding sodium nitrite solution in slight excess to a solution acidified with sulfuric acid, the sparingly soluble nitroso derivative separates in colorless needles melting at 136°. The perfectly pure monomethyl compound yields no benzylidene derivative on treatment with sodium acetate and benzaldehyde, but technical samples are rarely entirely free from salts of *p*-aminophenol, which is converted by benzaldehyde into the insoluble benzylidene *p*-aminophenol. A good technical sample should be completely soluble in three parts of concentrated hydrochloric acid. The diacetyl derivative is insoluble in cold water and melts at 97°; on gentle hydrolysis by warming with dilute alkali this is converted in the monoacetyl compound (soluble in alkali and precipitated by acid) which melts at 240°. The dibenzoyl derivative melts at 173°.

p-Dimethylaminophenol—The sulfate crystallizes in hexagonal tablets which are extremely soluble in water. The oxalate is moderately soluble in water and alcohol; it melts at 187° to 191°. The free base is fairly readily soluble in cold water; it melts at 75° and is extremely soluble in ether. On allowing a solution in sodium hydroxide to stand in air, the same dark color and pyridine-like odor are developed as with the monomethyl compound. On adding sodium nitrite to a solution in dilute acid, a reddish brown coloration is formed, with evolution of gas. On adding a saturated solution of potassium ferrocyanide to a fairly concentrated solution in dilute sulfuric acid, a white crystalline precipitate of the acid ferrocyanide soon separates. It forms an acetyl derivative melting at 78°, and a benzoyl derivative (soluble in dilute acid) which melts at 158°.

o-Methylaminophenol—The sulfate crystallizes in stout needles which are extremely soluble in water; the free base, which is slightly soluble in cold water but readily so in hot water, crystallizes in leaflets melting at 96°. It dissolves in alkali, forming a solution which slowly darkens to a dull green color on standing in air, giving a pyridine-like odor, but more slowly than the para compound. The free base and its sulfate are completely soluble in three parts of concentrated hydrochloric acid. On adding sodium nitrite to a solution in dilute acid, the nitrous compound is precipitated in colorless leaflets which melt with decomposition about 130° after darkening from 120° onwards (the melting point is rather indistinct and depends upon the rapidity with which the bath is heated). The derivative obtained on acetylation is a liquid which dissolves in cold water; on gentle hydrolysis by warming with dilute alkali it yields the monoacetyl compound (soluble in alkali and precipitated by acid) which melts at 150°. The dibenzoyl derivative melts at 113°.

p-Phenylenediamine—The hydrochloride crystallizes in leaflets which are readily soluble in water. The free base, melting at 140°, is moderately soluble in cold water and sparingly in ether. On adding to a cold dilute solution an excess of sodium acetate and then a few drops of benzaldehyde, the pale yellow dibenzylidene derivative is precipitated; this crystallizes from methyl alcohol, in which it forms a bright yellow solution, in thin leaflets, melting at 138°. Both the diacetyl and dibenzoyl derivatives melt at temperatures too high for convenient measurement.

QUANTITATIVE METHODS

It frequently happens that photographic developers placed upon the market consist of mixtures of developing agents or of impure simple substances, so that it may be necessary to separate and estimate the constituents of a mixture or to determine the purity of a sample of a single substance.

GROUP I—No direct method for determining the purity of a sample of *p*-hydroxyphenylglycine is available. An ash determination should be made, and the amount of matter insoluble in dilute sodium carbonate estimated. If a sulfite be present the sulfurous acid liberated by mineral acid should be determined by the method indicated below.

GROUP II—All the substances in this group should leave no ash on ignition; if there be any, it should be estimated. Likewise, all should dissolve in water and in ether without residue, and should leave no considerable residue when the main constituent is volatilized under atmospheric or reduced pressure.

The melting point forms a fairly satisfactory criterion of the purity when the sample is found to be completely soluble in ether.

The proportion of hydroquinone in a sample of chlorohydroquinone may be estimated by isolating and weighing the matter insoluble in warm benzene.

GROUPS III AND IIIa—Water-insoluble material and ash should be estimated; in Group III the amount of matter insoluble in alcohol should also be determined. The proportion of chloride, sulfate, sulfite, etc., should be determined; and in certain cases it may be well to estimate the total nitrogen by the Kjeldahl method, making certain, of course, that free ammonium salts are absent.

It is important in all cases to determine the amount of salts of *p*-aminophenol or aminocresol present, both in samples consisting principally of one of these compounds and in samples of methylated derivatives. The procedure is as follows:

Ten grams of the sample are dissolved in about 150 cc. of cold water (or, in the case of the free base, dilute hydrochloric acid). Heating must be avoided, since this may cause impurities to enter into solution which do not again separate on cooling. A slight excess of sodium acetate is then added, and to the cold solution about 10 cc. of benzaldehyde are run in. When the sample contains a relatively small proportion of aminophenol, as in samples of *p*-methylaminophenol sulfate, the amount of benzaldehyde should be considerably reduced. After standing over night the mixture, which should still contain excess of benzaldehyde, is filtered by suction, the solid well washed with water, dried in the steam oven, and weighed. A Gooch crucible answers satisfactorily.

The following factors are applied for expressing the result:

As *p*-aminophenol hydrochloride	0.738
As *p*-aminophenol sulfate	0.802
As *p*-aminophenol base	0.554
As 5-amino-2-cresol hydrochloride	0.756
As 5-amino-2-cresol sulfate	0.815
As 5-amino-2-cresol base	0.584

For the remaining substances in this group the simple though non-specific total nitrogen content must be determined and the assumption made that all the nitrogen is in the form of the pure substance.

INORGANIC RADICLES—When an ash has been found and shown to consist of a salt of an alkali metal, a weighed sample of the substance should be ignited in a platinum crucible and the residue repeatedly evaporated to dryness and heated to redness after adding a few drops of 20 per cent sulfuric acid; in this way the metal is completely converted into the sulfate.

Chlorides and bromides should be determined by the Volhard method. Direct estimation of alkali carbonate is difficult or even impossible in some instances, and may have to be effected by difference.

Sulfites are best estimated by distilling an acidified solution of the sample into alkali and titrating the distillate against standard iodine solution, running the sulfite into the iodine. A regular Kjeldahl distillation apparatus answers well for the purpose.

TYPICAL ANALYSES

For obvious reasons the sources of the material used for these typical analyses are not indicated; they represent a selection from a very large number performed in the years 1916–1918.

"MQ" DEVELOPER TUBE (APRIL 1916)—The total weight of material in the compartment containing the developing agent was 0.6276 g. This was placed on a filter and well washed with ether; the ethereal solution, on evaporation, left pure hydroquinone; the insoluble residue, when dried at 100°, weighed 0.1241 g. and was found to consist of pure *p*-methylaminophenol sulfate. The hydroquinone was not weighed, but estimated by difference.

"MQ" DEVELOPER TUBE (APRIL 1916)—A similar analysis on another tube showed total weight 0.5713 g.; ether-soluble material consisted of pure hydroquinone; ether-insoluble material weighed 0.1120 g. and consisted of technically pure *p*-aminophenol hydrochloride.

DEVELOPING AGENT (MARCH 1916)—The material was a light brown powder of rather moist appearance. It contained no substance soluble in ether, but dissolved partially in alcohol, the alcoholic extract depositing *p*-aminophenol hydrochloride on evaporation. 2.000 g. were boiled with alcohol and filtered on a weighed Gooch crucible. The insoluble residue was well washed with hot alcohol and dried to constant weight *in vacuo* over sulfuric acid. It weighed 0.728 g. and consisted of pure starch. The filtrate was evaporated to dryness and the residue dried at 115°; it weighed 0.998 g. Another 2.000 g. sample were heated in the oven at 115° to constant weight; it lost 0.308 g.

The material thus consisted of

	Per cent
p-Aminophenol hydrochloride	49.9
Starch	36.4
Moisture	15.4
	101.7

"METOL" (APRIL 1918)—This consisted of technical *p*-aminophenol hydrochloride, without a trace of methylated product.

"METOL" (APRIL 1918)—The label claimed the contents to be "Hydrochloride of methyl-*p*-amino-*m*-cresol guaranteed 96.3 per cent pure." The material consisted entirely of 5-amino-2-cresol hydrochloride, without a trace of methylated product.

"METOL SUBSTITUTE" (APRIL 1916)—The material was first extracted with ether, and the filtrate found to contain only pure hydroquinone. 2.7654 g. gave 0.5122 g. of hydroquinone, or 18.5 per cent. The residue showed the presence of sulfite and sulfate as the only acid radicles; on ignition, a residue consisting of sodium salts was left. *p*-Methylaminophenol was found by the usual methods, and the behavior of the material led to the suspicion that cane sugar was present. This was confirmed by boiling with strong hydrochloric acid, when the characteristic brown color and odor of caramel were developed. Further examination failed to show the presence of other substances.

The portion insoluble in ether was dissolved in water and diluted to 50 cc.; this solution in a 20 cm. tube gave a rotation of 2.90°, using mercury green light, corresponding to 0.932 g. cane sugar in the sample, or 33.7 per cent.

Another portion of the original sample was ignited in a platinum crucible and the residue converted into sodium sulfate; 1.3604 g. gave 0.5319 g. of sodium sulfate, corresponding to 34.7 per cent of sodium sulfite. (The sulfurous acid content was not determined as a check.)

For estimating the *p*-methylaminophenol sulfate, a portion was digested with sulfuric acid and the nitrogen determined by the Kjeldahl process; 1.4880 g. required 8.6 cc. of $N/10$ acid, corresponding to 0.148 g. *p*-methylaminophenol sulfate, or 10 per cent.

The material thus contained:

	Per cent
Hydroquinone	18.5
Cane sugar	33.7
Sodium sulfite	34.7
p-Methylaminophenol sulfate	10.0
	96.9

"METOL SUBSTITUTE" (JUNE 1916)—The material on treatment with ether yielded a soluble constituent which was identified as pyrogallol; the residue, which contained no nitrogenous matter, consisted entirely of sodium sulfite; the ethereal extract from 5.1215 g. gave, on evaporation, 1.3050 g. of pyrogallol or 25.5 per cent; the residue was acidified and the sulfurous acid distilled into alkali, which was then diluted to 200 cc. Of this solution 15.9 cc. were required by 60 cc. of standard iodine solution, equivalent to 50.0 g. sodium sulfite per liter, corresponding to a total of 3.773 g. sodium sulfite, or 73.8 per cent. Another sample was ignited with sulfuric acid: 1.2730 g. gave 1.0455 g. sodium sulfate, corresponding to 0.9280 g. sodium sulfite or 72.9 per cent.

The material thus consisted of:

	Per cent
Pyrogallol	25.5
Sodium sulfite	73.4
	98.9

DEVELOPING AGENT (JULY 1916)—Ether dissolved out a small amount of dark smeary material, which was not further investigated. The residue, on further examination, was found to consist of impure *p*-aminophenol hydrochloride mixed with lead chloride and a small amount of lead sulfate. The lead was determined by ignition with sulfuric acid: 1.7130 g. gave 1.1270 g. of lead sulfate, or 0.429 equivalent of lead per 100 g. of sample. In another sample chlorine and nitrogen were determined by collecting in alkali the gases evolved on heating with sulfuric acid in the Kjeldahl process: 1.6070 g. were heated with 25 cc. of sulfuric acid, the gases evolved during the early stages of digestion being absorbed in 25 cc. of 10 per cent alkali. This was diluted to 100 cc. 10 cc. of the solution required 22.6 cc. of $N/20$ silver nitrate after deducting the blank test, corresponding to 0.710 equivalent of chlorine per 100 g. of sample. The ammonia required 46.4 cc. of $N/10$ acid, corresponding to 0.289 equivalent per 100 g. of sample. Deducting this leaves 0.421 equivalent of chlorine combined as lead chloride; again deducting, there remains 0.008 equivalent of lead sulfate.

Composition of 100 g. of sample:

		Per cent
Impure *p*-aminophenol hydrochloride	0.289 equivalent or	42.1
Lead chloride	0.421 equivalent or	58.5
Lead sulfate	0.008 equivalent or	1.2
		101.8

The above analysis is of course accurate only to about 1 or 2 per cent, especially in the figure for *p*-aminophenol since all nitrogenous matter has been calculated as *p*-aminophenol hydrochloride.

DEVELOPING AGENT (SEPTEMBER 1916)—This material was stated by its label to be "Identical to Metol." On treatment with ether a considerable quantity entered into solution; the ethereal extract, on evaporation, left hydroquinone: 1.2140 g. gave 0.6300 g. or 52.0 per cent of hydroquinone. The insoluble portion was found to contain sulfite, sulfate, carbonate, iodide, sodium, potassium, and a salt of *p*-methylaminophenol.

Iodine estimation: 0.8996 g. gave 0.0613 g. AgI. Expressed as potassium iodide, 0.0487 g., or 5.4 per cent.

Sulfite estimation: 1.2140 g. required 36.0 cc. of standard iodine solution (1 liter corresponding to 50.0 g. of anhydrous sodium sulfite) corresponding to 0.179 g. or 14.7 per cent sodium sulfite.

Alkali metals: 0.2135 g. gave 0.0512 g. mixed sodium and potassium sulfates. This corresponds to 5.4 per cent potassium iodide plus 14.7 per cent sodium sulfite plus 3.7 per cent sodium carbonate.

Nitrogen estimation (Kjeldahl): 0.6030 g. required 11.5 cc. of $N/10$ acid, corresponding to 0.198 g., or 32.8 per cent of *p*-methylaminophenol sulfate.

Composition:

	Per cent
Hydroquinone	52.0
p-Methylaminophenol sulfate	32.8
Sodium sulfite	14.7
Potassium iodide	5.4
Sodium carbonate	3.7
	108.6

METOL SUBSTITUTE (JUNE 1918)—The material was extracted with ether, which, on evaporation, left no residue. Methyl alcohol dissolved a considerable proportion; the filtrate, on evaporation, left a residue consisting of pure ammonium *p*-toluenesulfonate, which was identified by the preparation of the corresponding sulfonic chloride and sulfonamide, both of which had the correct melting points. Further examination showed the presence of a salt of *p*-methylaminophenol and a small amount of some sodium salt. Sulfate was found to be present.

As ammonium *p*-toluene sulfonate has no developing action, the principal interest lay in the proportion of *p*-methylaminophenol present. A weighed quantity was accordingly dissolved in water and heated to boiling. To the boiling solution an excess of sodium carbonate solution containing a small amount of sodium sulfite was added, and the mixture boiled until every trace of ammonia was expelled. The residue was then immediately acidified with dilute sulfuric acid, and the nitrogen determined by the Kjeldahl method: 0.1200 g. required 8.5 cc. of $N/10$ acid corresponding to 0.146 g., or 12.0 per cent of methylaminophenol sulfate. The material thus contained 12.0 per cent *p*-methylaminophenol sulfate, the remainder consisting of ammonium *p*-toluenesulfonate together with a small proportion of sodium salts.

ADULTERANTS—These are of such diverse nature that it is impossible to suggest any general lines of examination. Among the adulterants and useless substitutes the following have been encountered:

Starch
Cane sugar
Citric acid
Sodium formate
Potassium oxalate
Rochelle salt
Potassium ferrocyanide
Boracic acid
Borax
Potassium bromide
Potassium iodide
Potassium nitrate
Sodium chloride
Sodium sulfate
Sodium sulfite
Sodium bisulfite
Sodium sulfide
Sodium hydroxide
Sodium carbonate
Ammonium chloride
Ammonium sulfate
Calcium sulfate
Magnesium sulfate
Lead chloride
Lead sulfate

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A SUMMARY OF THE LITERATURE ON THE SOLUBILITY OF SYSTEMS RELATED TO NITER CAKE[1]

By H. W. Foote

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In a recent article[2] Johnston has pointed out that "the best mode of using a solution of niter cake for any particular purpose could be ascertained from the appropriate solubility data." He has called attention, in particular, to the importance of such data for the three-component system Na_2SO_4–H_2SO_4–H_2O, and of four-component systems like Na_2SO_4–$FeSO_4$–H_2SO_4–H_2O. No system of the latter type has been investigated. There are 4 three-component systems which lead up to it of which only the following three have any importance:

(1) Na_2SO_4–H_2SO_4–H_2O
(2) Na_2SO_4–RSO_4–H_2O
(3) RSO_4–H_2SO_4–H_2O

Another system which may prove to be of some importance in connection with the utilization of niter cake is that consisting of Na_2SO_4–$(NH_4)_2SO_4$–H_2O.

I propose to review briefly the literature relating to the solubility of these systems, omitting older data obtained before the solubility relations in three-component systems were well understood. In some of the very recent publications, I have not been able to consult the original articles and in these cases the reference to *Chemical Abstracts* has been added.

Na_2SO_4–H_2SO_4–H_2O

This system has been investigated by D'Ans[3] and very recently by Pascal.[4] A few data are also given by Herz.[5] The results obtained by D'Ans were chiefly at 25°. The writer has recently repeated a number of his determinations and in general obtained excellent agreement. Pascal investigated the system under a wide range of temperature but only a summary of his results, expressed in a diagram without numerical data, has been published up to the present. The diagram is inaccurate in at least one respect, as it represents the solubility of the salt $Na_2SO_4.10H_2O$ far above its transition temperature, where it can no longer exist. The results at 25° taken from his diagram do not agree closely with those of D'Ans.

This system is not as simple as it might appear, for besides the decahydrate and the anhydrous salt, a series of four acid sulfates was found by D'Ans, each salt existing in contact with solutions of varying acid concentration between limits set by the formation of other solid phases. A transition temperature exists at 16.67°, at which temperature the three solid phases $Na_2SO_4.10H_2O$, Na_2SO_4, and $Na_3H(SO_4)_2.H_2O$ exist in equilibrium with solution and vapor. Below this temperature, the anhydrous salt cannot exist in stable equilibrium with acid solutions, and with increasing acidity the decahydrate is followed directly by an acid salt.

The solubility results in this system are important on account of the possibility of separating niter cake into its components by direct crystallization or leaching. This possibility is considered in detail by Saxton in the following article and no further mention is necessary here.

Na_2SO_4–RSO_4–H_2O

The first system of this type to be thoroughly investigated was that with magnesium sulfate.[1] Later, similar systems were investigated by Koppel[2] for R = Cu, Fe″, Co, Ni, Zn, Cd, Mn. Very recently, Schreinemaker and Prooye[3] have again investigated the system containing manganese as the bivalent metal, Massink[4] that containing copper, and LeChatelier and Bogitch[5] that with ferrous iron. Cameron and Seidell[6] have determined the solubility at 25° of calcium sulfate in solutions of sodium sulfate and in connection with the formation of salt deposits, van't Hoff[7] and others have investigated the same system. It is evident, therefore, that systems of this type have been investigated thoroughly. In many cases, the data are given for a considerable range of temperature. Excepting calcium sulfate, all the systems form double salts of the 1:1 type with either 2 or 4 molecules of water. Unlike most double salts, they are formed from the single salts by raising the temperature. The transition temperatures, at which the two single salts, double salt, solution, and vapor are in equilibrium, were determined in all systems investigated by Koppel. They all fall between the limits 8.7° and 22°. Below the transition temperature only the single salts crystallize. Beginning at temperatures slightly above the transition points, the double salts can be recrystallized from water without decomposition.

RSO_4–H_2SO_4–H_2O

The following systems of this type have been investigated, usually at 25°: R = Fe″,[8] R = Cu,[9] R = Ba,[10] R = Ca,[11] R = Be.[12] Very incomplete data for R = Zn are given by Hoffman[13] who describes an acid sulfate.

For copper and ferrous sulfates, and probably for all similar sulfates, the type of solubility with increasing concentration of sulfuric acid, is similar, the concentration of the sulfate decreasing with increasing acidity. Ferrous sulfate and zinc sulfate form acid salts from strongly acid solutions, while copper sulfate does not, giving ultimately the anhydrous sulfate.

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[1] Published at the request of the Division of Chemistry and Chemical Technology of the National Research Council.

[2] THIS JOURNAL, **10** (1918), 468.

[3] *Ber.*, **39** (1906), 1534; *Z. anorg. Chem.*, **49** (1906), 356; **61** (1909), 91.

[4] *Compt. rend.*, **164** (1917), 628.

[5] *Z. anorg. Chem.*, **73** (1912), 274.

[1] Van't Hoff and van Deventer, *Z. physik. Chem.*, **1** (1887), 170; Rooseboom, *Ibid.*, **2** (1888), 513.

[2] *Ibid.*, **42** (1902), 1; **52** (1905), 385.

[3] *Proc. Akad. Wetenschappen*, **15**, 1326; *Chem. Abs.*, **8**, 1068.

[4] *Z. physik. Chem.*, **92** (1917), 351; *Chem. Abs.*, **11**, 3184.

[5] *Rev. Metall.*, **12** (1915), 949; *Chem. Abs.*, **10**, 2460.

[6] *J. Phys. Chem.*, **5** (1901), 649.

[7] A summary of this work is found in *Z. anorg. Chem.*, **47** (1905), 244.

[8] Kenwick, *J. Phys. Chim.*, **12** (1908), 693; Wirth, *Z. anorg. Chem.*, **79** (1913), 360. Data are also given for ferric and aluminum sulfates. Florentin, *Bull. Soc. Chim.*, **13** (1913), 362.

[9] Bell and Taber, *J. Phys. Chem.*, **12** (1908), 171; Foote, *J. Am. Chem. Soc.*, **37** (1915), 288.

[10] Volkhonskii, *J. Russ. Phys.-Chem. Soc.*, **41**, 1763; *Chem. Abs.*, **5** (1911), 617.

[11] Cameron and Breazeale, *J. Phys. Chem.*, **7** (1903), 571.

[12] Wirth, *Z. anorg. Chem.*, **79** (1913), 357.

[13] *Z. angew. Chem.*, **23** (1910), 1672.

Barium sulfate becomes more soluble in strong sulfuric acid, as is well known, and an acid sulfate forms from strongly acid solutions.

Na_2SO_4–$(NH_4)_2SO_4$–H_2O

This system has recently been well investigated by Matignon and Meyer[1] through a considerable range of temperature. The work is of importance at present because of the possibility of using niter cake to absorb ammonia and produce ammonium sulfate. The attempts which have been made to do this have been summarized by Johnston.[2] They appear not to have been very successful thus far and the results obtained have been irregular. With the data which have now been published, it is possible to calculate exactly what can be done in this direction.

A double salt, $Na_2SO_4.(NH_4)_2SO_4.2H_2O$, forms, with a transition temperature at 59°. Above this temperature, only the single salts are deposited from solution.

Na_2SO_4–RSO_4–H_2SO_4–H_2O

No four-component system of this type has been thoroughly investigated. D'Ans has given a few data for solutions containing calcium sulfate. An investigation is in progress in this laboratory on such a system containing copper sulfate. It is to be hoped that investigators elsewhere may work out the data for other sulfates. The problem is an interesting one from a scientific standpoint as well as pointing out possible uses for niter cake.

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THE RECRYSTALLIZATION OF NITER CAKE[3]

By BLAIR SAXTON

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In this paper the solubility data of D'Ans[4] for 25° and of Pascal[2] for 0° will be used to calculate in some detail the extent of the separation of niter cake into its constituents which can be effected by leaching or crystallizing at these temperatures. The data of D'Ans are very good. Unfortunately Pascal has expressed his results in a triangular diagram only and data scaled from this are not reliable. Calculations have been made for 0°, however, and they are valuable in showing that the separation can be made more efficiently at that temperature than at 25°. Solubility determinations for temperatures lower than 25° are in progress in this laboratory and then the possibilities at these temperatures will be considered. Calculations somewhat similar to these which follow have recently been made by Hildebrand[5] and Blasdale.[6]

CRYSTALLIZATION AT 25°

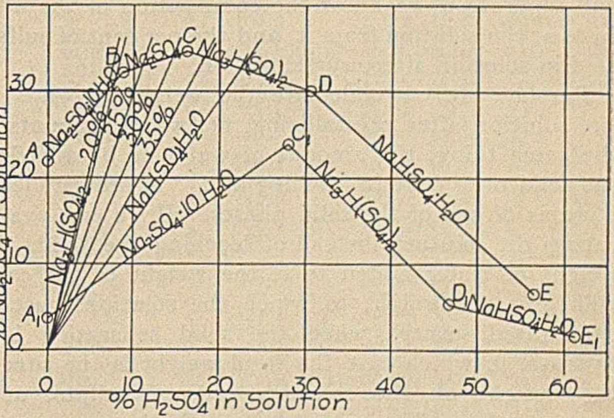
At this temperature we may crystallize the following solids: $Na_2SO_4.10H_2O$, Na_2SO_4, $Na_3H(SO_4)_2.H_2O$, $Na_3H(SO_4)_2$, $NaHSO_4.H_2O$, $NaHSO_4$, $NaH_3(SO_4)_2.1.5H_2O$, and $NaH_3(SO_4)_2$. Of these we may discard the last three, since their removal from solution takes out too much sulfuric acid. Further, $Na_3H(SO_4)_2.H_2O$ need not be considered since it rarely forms. The data of D'Ans, expressed in per cent of solution by weight, are given in Table I together with the composition of each solid phase considered.

TABLE I

	SOLUBILITY AT 25°		
	Solution		
SOLID PHASES	H_2SO_4	Na_2SO_4	H_2O
$Na_2SO_4.10H_2O$	0.00	21.90	78.10
$Na_2SO_4.10H_2O \rightleftarrows Na_2SO_4$	8.67	32.07	59.26
$Na_2SO_4 \rightleftarrows Na_3H(SO_4)_2$	16.34	34.64	49.02
$Na_3H(SO_4)_2 \rightleftarrows NaHSO_4.H_2O$	30.60	30.05[(a)]	39.35
$NaHSO_4.H_2O \rightleftarrows NaHSO_4$	56.49	6.68	36.83
Composition of Salts			
$Na_2SO_4.10H_2O$	0.00	44.10	55.90
$Na_3H(SO_4)_2$	18.70	81.30	0.00
$NaHSO_4.H_2O$	35.50	51.46	13.04
$NaHSO_4$	40.83	59.17	0.00

(a) Determined by H. W. Foote. D'Ans gives 26.30.

These solubility data are also plotted in the figure. Straight lines have been drawn between the points representing the univariant systems and the calculations are based on this approximation. Here also are shown lines radiating from the origin representing the composition of niter cakes of 20, 25, 30, and 35 per cent sulfuric acid, also similar lines for the two acid sulfates, $Na_3H(SO_4)_2$ and $NaHSO_4.H_2O$. The intersection of one of these lines with the solubility curve gives the composition of solution which will first become saturated with the solid phase represented by that branch of the curve intersected. This of course tells what solid will form first on crystallizing at 25°. For instance, it shows that a niter cake which is 25 per cent sulfuric acid is never saturated with the decahydrate; hence it never forms on crystallizing.[1]



Considering the lines of the diagram as straight and letting x and y represent the concentrations of sodium sulfate and sulfuric acid, respectively, in saturated solution, the equations for these lines become as follows:

$$AB,\ x = 21.90 + 1.173\ y$$
$$BC,\ x = 29.17 + 0.335\ y$$
$$CD,\ x = 39.90 - 0.322\ y$$
$$DE,\ x = 57.67 - 0.903\ y$$

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[1] *Compt. rend.*, **165** (1917), 787; **166** (1918), 115.

[2] *Loc. cit.*

[3] Published at the request of the Division of Chemistry and Chemical Technology of the National Research Council.

[4] *Loc. cit.*, preceding article.

[5] THIS JOURNAL, **10** (1918), 96.

[6] *Ibid.*, **10** (1918), 347.

[1] The point of saturation can also be calculated by solving two simultaneous equations: one, the equation for a branch of the solubility curve; the other, the equation for the line showing the composition of the niter cake or solute. The line AB in the diagram is represented by the equation $x = 21.90 + 1.173\ y$. A 20 per cent acid niter cake is represented by the equation $x = 4\ y$. On solving these we obtain $x = 7.75$ and $y = 31.00$.

Given these equations and the composition of the solute before crystallization, it is possible to calculate the weight of the solid separating and the composition of the residual solution. For instance, let us consider the solid crystallizing to be Na_2SO_4. If we represent the weights of sodium sulfate and sulfuric acid in solution before crystallization as n and s, respectively, and the amount of Na_2SO_4 separating from solution as z, then at any point along BC the following relation must exist:

$$\frac{n-z}{s} = \frac{x}{y} = \frac{29.17 + 0.335y}{y}$$

and, solving for z, $z = n - s\left(0.335 + \frac{29.17}{y}\right)$,

or if we are dealing with a niter cake whose weight is c and which is s per cent sulfuric acid, this becomes:

$$z = c - cs\left(0.01335 + \frac{0.2917}{y}\right)$$

If the solid separating is $Na_3H(SO_4)_2$, the value of z is calculated by means of a similar equation, *i.e.*,

$$\frac{n - 0.813z}{s - 0.187z} = \frac{39.90 - 0.322y}{y}$$

Hence we are able to calculate how much of any solid will separate if we know the composition of the niter cake or the solution from it, and the per cent of sulfate acid in solution after crystallization.

Further, we can calculate the weight of water in the solution after crystallizing, or, which amounts to the same thing, the amount of water to be added to the solid niter cake in leaching at 25° in order to leave z grams of one of the solid phases. If we are evaporating the solution instead of leaching the solid, this weight of water added to c, the weight of the cake, will give the weight to which the solution must be evaporated, except when the solid separating is a hydrate, in which case the total weight is the sum of the weight of the solution—sodium sulfate, acid, water, and z. The extent to which the evaporation must be carried can also be very easily controlled by testing the acid concentration of the solution. Again considering the solid separating to be Na_2SO_4, w, the weight of water may be calculated as follows:

$$\frac{w}{s} = \frac{100 - (x + y)}{y} = \frac{70.83 - 1.335y}{y}$$

$$w = s\left(\frac{70.83}{y} - 1.335\right),$$

or if c is the weight of the niter cake or solute and s its acid concentration,

$$w = cs\left(\frac{0.7083}{y} - 0.01335\right)$$

Similarly, general calculations can be made for each of the other solid phases. The results for those phases which are here considered are assembled in Table II.

The equations are much simplified for any given value of s. For instance, if we take a solution of 100 g. of a 35 per cent acid niter cake which deposits crystals of $Na_3H(SO_4)_2$ first on crystallizing at 25°, we find that since $s = 35$ and $c = 100$,

$$z = 87.3 - \frac{744.8}{0.8732y - 7.461}$$

$$w = (35.0 - 0.187z)\left(\frac{60.10}{y} - 0.678\right)$$

If we know the value of both x and y for the solution in equilibrium with a given solid, we may avoid using these general equations. Again, starting with 100 g. of 35 per cent acid niter cake, we may calculate the maximum amount of $Na_3H(SO_4)_2$ that can separate by using the data for the point D in the diagram. This gives us

$$\frac{65.00 - 0.813z}{35.00 - 0.187z} = \frac{30.05}{30.60} = 0.982,$$

from which z becomes 48.66. Then the weight of sulfuric acid left in solution, $35.00 - 0.187z$, becomes 25.90. This is the type of calculation which has been used mostly in this paper, since it tells us the most we can do in separating any one solid phase. Hence in speaking of crystallizing $Na_2SO_4.10H_2O$, Na_2SO_4, $Na_3H(SO_4)_2$, or $NaHSO_4.H_2O$, we refer to crystallizing each to the points B, C, D, and E, respectively. If, however, a specific use of niter-cake solution requires a certain acid concentration, one can tell from the figure what will first crystallize, and calculate how much will separate, and how much sodium sulfate and sulfuric acid will be left in solution by using the general equations.

In separating niter cake into its constituents either by leaching or crystallizing at 25° we have the following possible processes which may be used separately or combined:

(A) Remove $Na_2SO_4.10H_2O$ from solution. This may be done by evaporating the solution to a calculated weight, or just to an acid content of 8.67 per cent, or by leaching completely with the calculated amount of water. The solute (sodium sulfate + sulfuric acid) will then be 21.28 per cent acid. Of the niter cakes here considered only the one which is 20 per cent acid can deposit this salt at 25°.

(B) Remove Na_2SO_4 from solution. This can be done exactly as A. The acid content of the solution at crystallization, however, will be 16.34 per cent. The solute will be 32.05 per cent sulfuric acid.

(C) Remove $Na_3H(SO_4)_2$ from solution by processes similar to A and B. The concentration of sulfuric acid in the final solution should be 30.60 per cent, and in the solute, 50.45 per cent.

(D) Recrystallize the $Na_3H(SO_4)_2$ from C by first removing Na_2SO_4 by process B and then crystallizing $Na_3H(SO_4)_2$ from the filtrate. 100 g. $Na_3H(SO_4)_2$ when thus treated will give 41.66 g. Na_2SO_4 by evaporating to 156.1 g. or leaching with 56.1 g. of water. The filtrate will then deposit 33.81 g. $Na_3H(SO_4)_2$ when evaporated to 74.2 g. The solution will then contain 12.15 g. of sodium sulfate and 12.38 g. of acid. The end result in concentration is the same as C, but 12.38 g. of sulfuric acid have been recovered in solution which otherwise would be in solid $Na_3H(SO_4)_2$. The result of recrystallizing any amount of $Na_3H(SO_4)_2$ in this way can be calculated from these data.

TABLE II

SOLID PHASE	EXPRESSION FOR z	EXPRESSION FOR w
Na_2SO_4	$c - cs\left(0.01335 + \frac{0.2917}{y}\right)$	$cs\left(\frac{0.7083}{y} - 0.01335\right)$
	$n - s\left(0.335 + \frac{29.17}{y}\right)$	$s\left(\frac{70.83}{y} - 1.335\right)$
$Na_3H(SO_4)_2$	$c\left(1.145 - 0.007765s + \frac{8.544 - 0.4569\,s}{0.8732\,y - 7.461}\right)$	$(cs - 18.7\,z)\left(\frac{0.6010}{y} - 0.00678\right)$
	$\frac{39.90\,s - (0.322\,s + n)y}{7.461 - 0\ 8732\,y}$	$(s - 0.187\,z)\left(\frac{60.10}{y} - 0.678\right)$
$NaHSO_4.H_2O$	$c\left(1.197 - 0.001165s + \frac{24.51 - 0.6005\,s}{0.8351\,y - 20.47}\right)$	$(cs - 35.5\,z)\left(\frac{0.4233}{y} - 0.000973\right)$
	$\frac{57.67\,s - (0.903\,s + n)y}{20.47 - 0.8351\,y}$	$(s - 0.355\,z)\left(\frac{42.33}{y} - 0.0973\right)$

c = the weight of niter cake or solute.
s = the per cent of sulfuric acid in the niter cake or solute.
z = the weight of solid separating.
n = the weight of sodium sulfate in the niter cake or solute.
y = the per cent of sulfuric acid in solution after crystallization.
w = the weight of water in solution after crystallization.

(E) Remove $NaHSO_4.H_2O$ from solution by the methods given for A, B, and C. In this case the concentration of acid in the solute will be 89.43 per cent and in the solution, 56.49 per cent. The only advantage in crystallizing this acid sulfate is to raise the concentration of acid. By doing this, much of the acid is removed from solution. Some of this could be recovered by recrystallizing, first separating $Na_3H(SO_4)_2$ and then $NaHSO_4.H_2O$. In order to make a good recovery of acid, this would involve too many operations to be practical. $NaHSO_4.H_2O$ is 35.50 per cent sulfuric acid, 51.46 per cent sodium sulfate, and 13.04 per cent water and corresponds to a 40.83 per cent acid niter cake. Its saturated solution may contain as much as 56.49 per cent of acid. Uses may be found for its solution without further treatment.

Finally these processes may be combined to considerable advantage. In Table III will be found such combinations as BCD. This means that Na_2SO_4 has been removed from the solution of a niter cake, then $Na_3H(SO_4)_2$ has been crystallized from the filtrate, and, finally, this acid salt has been recrystallized and the residual solutions, having the same concentration, have been combined. In making calculations for these combined processes the writer found it convenient to work out the results which could be obtained with 100 g. of solute for each case and from that data to make the calculations desired. After completing process B, for example, the solutions will always have the same composition independent of the composition of the original niter cake. The same is true for process C. The data for these two solutions are as follows:

After Na_2SO_4 has been removed from solution, 100 g. of the solute in the filtrate will contain 32.05 g. of acid and 67.95 g. of sodium sulfate. This filtrate, on evaporation to 127.27 g., will give 57.96 g. of $Na_3H(SO_4)_2$ and a solution which contains 20.83 g. of sodium sulfate and 21.21 g. of sulfuric acid.

After $Na_3H(SO_4)_2$ has been crystallized from solution, 100 g. of the solute in the filtrate will contain 50.45 g. of acid and 49.55 g. of sodium sulfate. When this filtrate is evaporated to 123.5 g. it will deposit 92.21 g. of $NaHSO_4.H_2O$ and leave a solution which contains 17.71 g. of acid and 2.10 g. of sodium sulfate.

In Table III are the results of such treatments as have been outlined on 100 g. of niter cake of 20, 25, 30, and 35 per cent acid. In column four is given the weight at final crystallization in any series of processes. If the combined process is BC the weight for C is given, the weight for B having previously been given. If the final process is D, two weights are given, the first being the weight at which Na_2SO_4 separates, the latter that at which $Na_3H(SO_4)_2$ is removed in the recrystallization of $Na_3H(SO_4)_2$.

TABLE III

H_2SO_4 in niter cake Per cent	Treatment	Number of operations	Weight at final crystallization	H_2SO_4 in solution Per cent	H_2SO_4 in solute Per cent	H_2SO_4 recovered in solution Per cent	Na_2SO_4 left in solid Per cent
20.0	A	1	244.3	8.67	21.28	100.0	7.5
	B	1	160.0	16.34	32.05	100.0	47.0
	BC	2	79.4	30.60	50.45	66.2	83.8
	BCD	4	56.5, 26.8	30.60	50.45	88.5	78.3
	BCDD	6	19.1, 9.1	30.60	50.45	96.1	76.4
	C[1]	1	102.6	30.60	50.45	10.3	97.5
	CD	3	149.7, 71.2	30.60	50.45	69.7	82.9
	BCE	3	32.4	56.49	89.43	23.2	99.3
	BCDDE	7	33.8	56.49	89.43	33.8	99.0
25.0	B	1	175.0	16.34	32.05	100.0	29.3
	BC	2	99.3	30.60	50.45	66.2	78.3
	BCD	4	70.6, 33.6	30.60	50.45	88.5	71.0
	C[1]	1	112.9	30.60	50.45	40.0	86.9
	CD	3	125.1, 59.5	30.60	50.45	79.7	73.9
	CDD	5	42.3, 20.1	30.60	50.45	93.1	69.5
	BCE	3	40.5	56.49	89.43	23.2	99.1
30.0	B	1	190.0	16.34	32.05	100.0	9.1
	BC	2	119.3	30.60	50.45	66.2	72.1
	BCD	4	83.7, 40.3	30.60	50.45	88.5	62.7
	C[1]	1	123.1	30.60	50.45	59.9	74.5
	CD	3	100.5, 47.8	30.60	50.45	86.4	63.6
	BCE	3	65.1	56.49	89.43	23.2	98.8
35.0	C	1	133.3	30.60	50.45	74.0	60.9
	CD	3	76.0, 36.1	30.60	50.45	91.2	48.2
	CE	2	63.4	56.49	89.43	26.0	98.3
	CDE	4	78.2	56.49	89.43	32.0	98.0

[1] This can be done from the original solution by evaporating to the weight given and allowing to stand at 25°. All $Na_2SO_4.10H_2O$ and Na_2SO_4 will have changed into the acid salt at this concentration.

It is evident from these figures that the way to proceed with a niter cake of less than 25 per cent acid in order to produce a solute and solution which are 50.45 per cent and 30.60 per cent acid, respectively, is to remove Na_2SO_4 and $Na_3H(SO_4)_2$ consecutively from solution, recrystallize the acid sulfate, and combine the solutions (process BCD). This involves four operations and leaves 88.5 per cent of the acid in solution and over 70 per cent of the sodium sulfate in the solid. The recrystallization of the acid sulfate could be repeated, thus recovering 96.1 per cent of the acid but it would mean six operations and hence is hardly practical. If the niter cake is over 25 per cent acid, $Na_3H(SO_4)_2$ can be efficiently separated from the original solution, recrystallized, and the solutions combined. This takes only three operations. If the niter cake is 25 to 32 per cent acid, the recovery of sulfuric acid will be from 80 to 85 per cent. If the niter cake is 32 to 50 per cent acid, 91.2 per cent of the latter will be recovered in solution. At 25° no method for concentrating the acid in solution as far as the point E in the diagram (a solution of 56.4 per cent, and a solute of 89.43 per cent acid) is possible without removing 70 to 80 per cent of the acid. Of course $NaHSO_4.H_2O$ can be removed so that the solution will have any desired concentration represented along the line DE. Proceeding for short distances along DE would not sacrifice an unreasonable amount of acid.

In order to test the practicability of these calculations, experiments were made on the removal of Na_2SO_4 and $Na_3H(SO)_2$ from solutions of 100 g. of 30 per cent acid niter cake. The solutions were made by warming 158.7 g. of recrystallized Glauber's salt with 31.6 g. of 95 per cent sulfuric acid in Erlenmeyer flasks. A small amount of anhydrous sodium sulfate remained undissolved.

One sample of such a solution, since it weighed 190.3 g., was cooled without further evaporation, corked, and immersed in a thermostat at 25° for 48 hrs. The Na_2SO_4 was filtered through a small suction filter and washed free from mother liquor with the solution recommended by D'Ans, consisting of 50 cc. of water, 10 cc. of concentrated sulfuric acid, and 75 cc. of alcohol. After removing the mother liquor, the salt was washed with alcohol and then with ether. When dry it weighed 7.0 g., while the amount calculated for the point C is 6.4 g. A little $Na_3H(SO_4)_2$ no doubt separated since the solution analyzed 16.42 per cent sulfuric acid and D'Ans found 16.34 per cent for the univariant point C.

A second sample of the solution was evaporated to 124 g. and treated in the same way. The calculated weight of the solution at crystallization is 123.1 g. but the last stages of evaporation offered some difficulties since the solution practically solidified. The acid sulfate was washed and dried in the same way as was the Na_2SO_4. When dry it weighed 68.5 g., while the calculated weight is 64.4 g. Here again the univariant point was reached, since the solution analyzed 30.61 per cent acid, while D'Ans found 30.60 per cent. The salt on analysis for sulfuric acid proved to be pure $Na_3H(SO_4)_2$. Considering the roughness of these experiments, both of them can be considered as satisfactory checks on the calculations.

RECRYSTALLIZATION AT 0°

The data of Pascal have been scaled from his diagram and are given in Table IV and plotted in the figure. They are expressed in per cent by weight of solution.

TABLE IV

SOLID PHASES	Solution		
	H_2SO_4	Na_2SO_4	H_2O
$Na_2SO_4.10H_2O$	0.00	3.68	96.26
$Na_2SO_4.10H_2O \rightleftarrows Na_3H(SO_4)_2$....	28.14	23.93	47.86
$Na_3H(SO_4)_2 \rightleftarrows NaHSO_4.H_2O$.....	46.81	5.26	47.60
$NaHSO_4.H_2O \rightleftarrows NaHSO_4$........	61.28	1.84	36.29

These data are inaccurate as has been pointed out, but they are valuable, as the following calculations will show. These calculations have not been carried out in as great detail as those for 25° because of the data on which they are based.

At 0° we have four solids which can reasonably be separated: $Na_2SO_4.10H_2O$, $Na_3H(SO_4)_2$, $NaHSO_4.H_2O$, and $NaHSO_4$. Solutions of niter cake of the range of compositions considered in this paper will first be saturated with Glauber's salt at 0°. The removal of this alone is very effective. It will leave all the acid in solution and the concentration of acid in the solution and solute will be 28.14 and 54.04 per cent, respectively. If $Na_3H(SO_4)_2$ is then crystallized from the solution, 82.6 per cent of the acid will be recovered, the solution will be 46.81 per cent acid, while the concentration of acid in the solute will be 89.90 per cent. Recrystallizing the acid sulfate, by removing $Na_2SO_4.10H_2O$ and $Na_3H(SO_4)_2$, successively, from its solution, and then combining the solutions will not change the composition of the solution or solute, but will recover in solution 97.0 per cent of the acid. 100 g. of $Na_3H(SO_4)_2$ recrystallized in this way at 0° will give 148.3 g. of $Na_2SO_4.10H_2O$ when treated with 114.7 g. of water or its solution evaporated to 214.7 g. The solution will then separate 17.43 g. of $Na_3H(SO_4)_2$ when evaporated to 50.3 g. The final solution will contain 1.73 g. of sodium sulfate and 15.44 g. of sulfuric acid.

If higher concentration of acid is desired this may be accomplished by evaporation and removal of $NaHSO_4.H_2O$. This also can be done efficiently as can be seen from a glance at Table V. By removing Glauber's salt, $Na_3H(SO_4)_2$, and $NaHSO_4.H_2O$, successively, from solution we are able to recover 77.7 per cent of the acid and obtain, as the result of these three operations, a solute and solution of 97.10 and 61.28 per cent sulfuric acid, respectively. From 98.7 to 99.4 per cent of the sodium sulfate in the cake is left in the solid. Any further desired concentration can be effected from this point since there is little sodium sulfate left in solution and very little if any of the acid salts can separate and hence little sulfuric acid can be removed. In other words, the solution now behaves like a solution of sulfuric acid only.

The results obtained with 100 g. of niter cake of several compositions are given in Table V. The meaning of the letters in column two is the same as in Table III.

TABLE V

H_2SO_4 in niter cake Per cent	Treatment	Number of operations	Weight at final crystallization	H_2SO_4 in solution Per cent	H_2SO_4 in solute Per cent	H_2SO_4 recovered in solution Per cent	Na_2SO_4 left in solid Per cent
20.0	A	1	213.9	28.14	54.04	100.0	78.7
	AC	2	53.8	46.81	89.90	82.6	97.7
	ACD	4	40.0, 9.4	46.81	89.90	97.0	97.3
	ACE	3	27.9	61.28	97.10	77.7	99.4
25.0	A	1	210.6	28.14	54.04	100.0	71.6
	AC	2	67.2	46.81	89.90	82.6	97.1
	ACD	4	50.0, 11.7	46.81	89.90	97.0	96.4
	ACE	3	34.9	61.28	97.10	77.7	99.2
30.0	A	1	207.4	28.14	54.04	100.0	63.6
	AC	2	80.7	46.81	89.90	82.6	96.0
	ACD	4	60.0, 14.0	46.81	89.90	97.0	95.3
	ACE	3	41.9	61.28	97.10	77.7	99.0
35.0	A	1	204.2	28.14	54.04	100.0	45.8
	AC	2	94.1	46.81	89.90	82.6	95.0
	ACD	4	70.0, 16.4	46.81	89.90	97.0	99.1
	ACE	3	48.9	61.28	97.10	77.7	98.1

It is evident that crystallization or leaching at 0° is much more effective than at 25° in that greater concentration and recovery of acid can be effected with fewer operations at the lower temperature. It is interesting to note in this connection that Wood[1] has used a system of cold water percolation in order to concentrate acid in the solution from niter cake, and that this treatment has been recommended by Prideaux.[2] Unfortunately, at the present time the data are not available for temperatures between the two given. It may be possible that it is unnecessary to use a temperature as low as 0° in order to obtain a satisfactory separation. Solubility determinations for this system at 12° are being carried out in this laboratory by Professor Foote, who suggested this paper to the writer.

In the preceding paper reference has been made to the work of Matignon and Meyer on the solubility relations in the system Na_2SO_4–$(NH_4)_2SO_4$–H_2O. The writer proposes to treat this system as he has treated the system discussed in the present paper.

SUMMARY

General equations have been developed for the system Na_2SO_4–H_2SO_4–H_2O, at 25°, by means of which we can calculate how much of any one solid phase will separate from a solution if we know the composition of the original solute and the acid concentration of the solution after crystallization.

General equations have also been developed for this system at 25° by means of which we may calculate the weight of water in the solution after crystallization, or the weight of water to be added to the solid niter cake in order to leave a calculated weight of one of the solid phases.

A very simple type of calculation has been applied to niter cake of several compositions, by which the maximum amount of each solid phase which can be removed from solution at 25° and at 0° has been calculated.

Leaching or crystallizing processes have been suggested by which sulfuric acid may be concentrated in the solution and sodium sulfate in the solid, at the two temperatures mentioned.

It was found that this separation can be done much more efficiently at the lower temperature.

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[1] *J. Soc. Chem. Ind.*, **36** (1917), 1216A.

[2] *Ibid.*, **36** (1917), 1216B.

THE FORMATION OF AROMATIC HYDROCARBONS FROM NATURAL GAS CONDENSATE[3]

By J. G. Davidson

Received May 23, 1918

INTRODUCTION

In several papers which have appeared recently Zanetti[4] has shown that it is possible to produce aromatic hydrocarbons by the thermal decomposition of straight-chain hydrocarbons of low molecular weight.

Previous to this, Bone and Coward[1] had passed ethane, ethylene, and acetylene through porcelain tubes at various temperatures from 500° to 1000° C. and had noted that the decomposition of ethylene gave a black, viscous tar. The quantity of tar was too minute to admit of analysis but they mentioned the fact that a few crystals of naphthalene were noticed also. They hold aromatic formation to be produced by the breaking down of ethylene to acetylene from which the aromatic hydrocarbons are produced by polymerization.

Pring and Fairlie[2] found that acetylene at high temperatures and in the presence of hydrogen produces methane for the most part, although some ethane was formed also. When ethylene and hydrogen were heated together no acetylene was produced even at very high temperatures. Methane, however, was produced in large quantities.

Jones[3] studied the formation of aromatic compounds in coal tar and is of the opinion that acetylene plays an unimportant part in the reaction, inclining more to the belief that the ring bodies are formed directly from olefines with the splitting out of hydrogen.

Previous work in this laboratory pointed to conclusions which were similar to Jones', and in an effort to get a further insight into the reaction the following work was undertaken:

It was decided to divide the work into several parts and investigate each as fully as time allowed, for it was quite evident from the beginning that any one of the separate fields was capable of large expansion with possible loss of the original aim.

The divisions of the work are as follows: (1) The effect of catalyzers on the decomposition of straight-chain hydrocarbons of low molecular weight. (2) The influence of temperature and of pressure on the production of aromatic hydrocarbons. (3) The formulation of the reaction,

$$\text{Straight-chain hydrocarbons} \longrightarrow \text{Aromatic hydrocarbons}$$

EXPERIMENTAL

MATERIAL—The material used was the ethane-propane fraction of natural gas condensate, supplied in steel tanks under high pressure. The tanks are built on the siphon system, a pipe reaching almost to the bottom, so the composition of the delivered gas remains almost constant. Analysis of the gas showed it to be composed almost entirely of the two hydrocarbons, although some butane, and possibly some pentane, was also present. No other gases were present in the original material, although tests were made for oxygen, carbon dioxide, olefines, and hydrogen.

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[3] This paper is condensed from a dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Faculty of Pure Science of Columbia University.

The work was begun under the direction of Dr. J. E. Zanetti and is, in part, a continuation of his work. After the summer of 1917, when Dr. Zanetti entered the Chemical Warfare Service, the work was carried on more or less independently although I am glad to thank Dr. Nelson, Dr. Freas, and Dr. Fisher for their many invaluable suggestions, and without whose help the work could not have been finished.

[4] "The Thermal Decomposition of the Propane-Butane Fraction from Natural Gas Condensate," This Journal, **8** (1916), 674; "The Thermal Decomposition of the Ethane-Propane Fraction from Natural Gas Condensate," *Ibid.*, **8** (1916), 777; "Aromatic Hydrocarbons from the Thermal Decomposition of Natural Gas Condensate," *Ibid.*, **9** (1917), 474.

[1] "Thermal Decomposition of Hydrocarbons," *J. Chem. Soc.*, **93** (1908), 1197.

[2] "Synthesis of Hydrocarbons at High Temperatures," *Ibid.*, **99** (1911), 1796.

[3] "Aromatic Formation," *J. Soc. Chem. Ind.*, **36** (1917), 3.

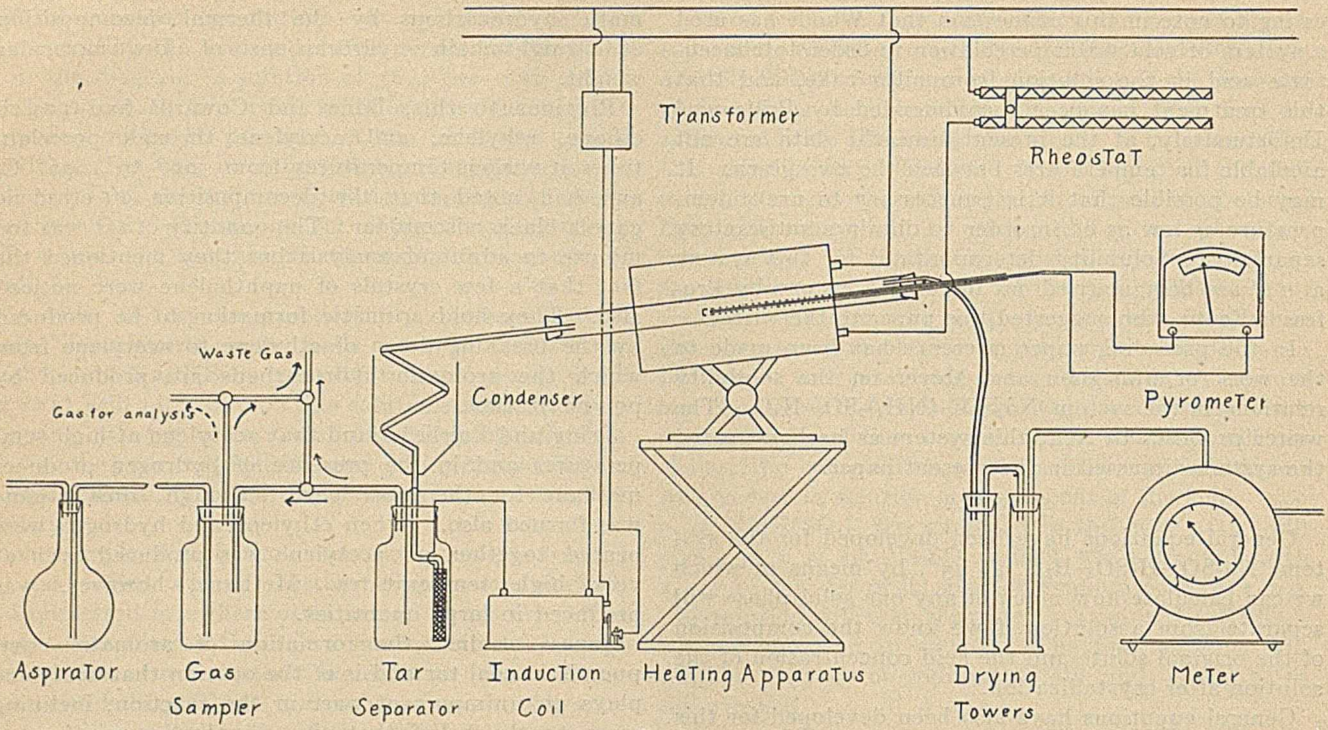

FIG. 1.

APPARATUS—The arrangement of the apparatus will be understood from Fig. 1. The gas was led through the referee meter, capable of being read to one-thousandth part of a cubic foot, then through the calcium chloride towers to the cracking chamber. The cracking chamber was a silica tube one inch in diameter about 2 ft. long and could be heated by the resistance furnace shown. The temperature could be controlled within a few degrees by the adjustable rheostat, while its actual value was read by means of the pyrometer. After the gas had been cracked it was quickly cooled in the metal condenser and passed into the precipitator. (At first a small copper plate and a fine iron wire were kept charged at opposite sides of the bottle. This did not work satisfactorily and the inlet tube was then surrounded with wire gauze as shown in the figure. This worked well for a time, as the gas had to pass through the charged wire meshes to escape, and deposition therefore was easy. After some time the meshes of the gauze became stopped up and required frequent renewal. The form of precipitator was then changed to that shown in Fig. 2, which was very satisfactory.) From the tar precipitator the gas was allowed to escape, as shown by the light arrow, or by-passed in the direction of the heavy arrow when a sample was being collected. This arrangement was necessary to prevent a change in the rate of flow through the cracking chamber, which was caused when trying to take a sample direct from the tar precipitator.

After a sample of sufficient volume had collected in the gas sampler the gas was allowed to pass in the same direction for a half hour longer in order that all parts of the apparatus might be in equilibrium. Failure to do this produced results that could not be checked. After a half hour had elapsed the stopcocks were turned so the gas followed the light arrow again and the collected sample of gas was forced out into a gas collecting bottle by way of the dotted arrow.

The apparatus for the analysis of the cracked gas was a modification of Burrell's gas apparatus.[1] Nothing new is claimed for this apparatus except its greater accessibility and ease of manipulation. It is shown in Fig. 3. Babb pipettes with an extra stopcock blown in the bend, as shown, were substituted for the Ostwald pipette in Burrell's apparatus. This extra stopcock facilitates refilling and cleaning the pipettes without the necessity of disconnecting from the main part of the apparatus. Beyond this the form of the Babb pipette lends itself admirably to rapid and complete absorption.

The slow combustion pipette (B) was made of transparent quartz rather than glass in order to reduce breakage. When using the ordinary glass pipette for slow combustions the oxygen would sometimes catch fire and burn at the point where the capillary opens out into the pipette. This would always result in a fracture at that point; furthermore, it was necessary after a combustion to wait almost 5 min. before the glass was cool enough to allow the mercury, which always had some drops of water on the surface, to be raised. After considerable trouble from both of these causes it was decided to have the pipette made of silica. The pipette as described gives the best of satisfaction.

Copper oxide was used to determine the hydrogen. The copper oxide was also enclosed in a tube of transparent silica, in preference to glass, which will break if drops of condensed water are drawn into the hot part of the tube. Use of a silica tube was suggested for this purpose by Suydam,[2] but it was found best

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[1] "New Forms of Gas Analysis Apparatus," THIS JOURNAL, 4 (1912), 296.

[2] "A New Model of the Burrell and Oberfell Apparatus for the Analysis of Illuminating Gas," THIS JOURNAL, 9 (1917), 972.

to make the tube horizontal rather than vertical as he advises. This position prevents stoppages, which happen after a time with the vertical form.

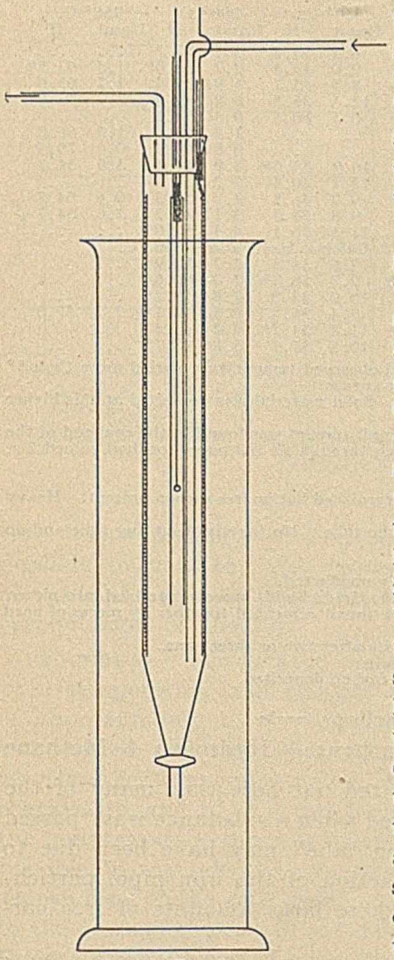

Fig. 2

PROCEDURE—The gas was led through the cracking chamber at the rate of 0.5 cu. ft. per hr., the rate of flow being frequently checked with a stop-watch. The temperature of the silica tube was rapidly raised to the desired point and kept there by adjusting the rheostat. When the temperature had become constant and the gas had passed through the tube and tar precipitator for sufficient time to sweep out all traces of gas from a preceding run, a sample was taken as described before, and the temperature of the tube raised for the next determination. While equilibrium was being reached again the first sample of gas was analyzed.

When catalyzers were used in the form of foil or gauze, pieces of uniform size were cut, rolled up to fit the tube snugly, and pushed in so the entire heated zone was filled with catalyzer. When small pieces of material had to be used for catalyzer the cracking tube was packed with loose material, which was held in place with a plug of copper gauze, preliminary work having shown that copper has no decided effect as catalyzer.

GAS ANALYSIS—All capillary errors and the larger error due to gas left in the copper oxide tube have been carefully determined and allowed for in the reports of analysis. As preliminary work showed no other gases to be present, unsaturated hydrocarbons, hydrogen, and saturated hydrocarbons were the only ones determined.

Pipettes 1 and 2 (Fig. 3) contained 30 per cent potassium hydroxide. Pipette 3 contained saturated bromine water.

The unsaturated hydrocarbons were determined by absorption in Pipette 3, one passage of the gas being sufficient if the olefine content of the gas was below 17 per cent. When the unsaturated hydrocarbons existed in greater amounts it was necessary to pass the gas through this pipette twice. Complete absorption is definitely shown by the presence of bromine vapor above the aqueous layer. Before measuring the amount of absorption it was necessary to pass the gas through Pipettes 1 and 2 to remove all traces of bromine vapor. Otherwise, the bromine causes a heavy sludge of mercuric bromide to form in the measuring pipette. This sludge clings to the sides of the tube and makes further work impossible.

It was necessary to use bromine water for the absorption of olefines, because sulfuric acid, either fuming or concentrated, was found to absorb some of the saturated hydrocarbons left in the gas which had been cracked at low temperatures. Above 750° C. the residual saturated hydrocarbons consisted solely of methane, so either sulfuric acid or bromine water could be used for gas cracked above this temperature.

After the contraction due to the absorption of the unsaturated hydrocarbons was measured, the gas was slowly passed through the copper oxide tube to the slow combustion pipette and back, until no further contraction occurred. The shrinkage was calculated as hydrogen. The temperature of the copper oxide tube was kept at 310° C. by means of a nichrome resistance heater controlled by a rheostat. This temperature was found to give rapid absorption of hydrogen, without noticeably attacking the saturated hydrocarbons still present.

The residue was then passed into the silica slow-combustion pipette, the wire brought to low whiteness, and the oxygen passed in. In samples taken above 600° C. the residue consisted solely of methane and ethane, and above 750° C. only methane survived.

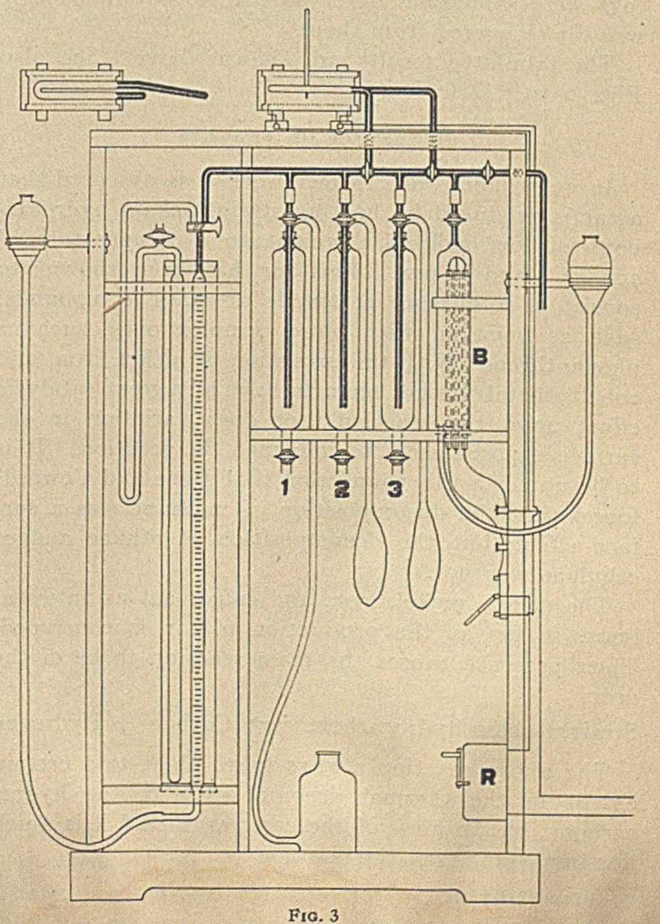

Fig. 3

CATALYZER	550° C.		600° C.		650° C.		700° C.		750° C.		800° C.		850° C.		900° C.		950° C.	
	Unsat.	H	Unsat.	H.	Unsat.	H	Unsat.	H	Unsat.	H	Unsat.	H	Unsat.	H	Unsat.	H	Unsat.	H
None[1]	4.0	0.9	8.0	4.8*	18.0	10.9	24.6	13.3	27.2	19.8	17.6	28.9	8.9	39.6	5.3	50.7	...	..
Pumice (Coarse)[2]	5.3	4.9*	12.3	2.3	23.7	4.8*	28.4	19.8	21.8	30.5	19.5	32.5*	9.0	43.4	2.7	56.0*	1.5	63.5*
Pumice (Fine)[3]	2.8	2.5	5.8	3.9	21.7	13.8	29.6	16.6*	24.2	27.0	19.8	33.5	8.5	45.7	1.9	55.4	1.7	63.0
Brass (Gauze)[4]	2.6	4.0*	4.2	3.2	12.2	7.3	24.8	10.1*	27.7	19.4*	15.5	26.2	12.1	36.5	6.9	44.9	3.7	53.6*
Nickel (Gauze)[5]	3.3	4.2	9.3	10.3	3.6	61.0*	1.7	69.7	1.8	68.2	0.5	82.0	0.5	80.5	0.3	84.5	...	..
Iron (Gauze)[6]	3.6	6.1	10.9	7.1	21.5	11.9	26.9	21.2*	7.1	54.5*	..	..	..	..	1.9	62.8	1.5	66.8
Iron (Strips)[6]	2.0	3.5	11.0	5.9*	22.8	11.2	16.3	37.8*	5.6	56.0	1.5	64.2	..	..	0.8	60.3	0.0	70.5
Chromium (Lumps)[7]	4.6	2.1*	7.9	2.1*	18.4	6.9*	28.3	13.7	28.8	22.8	22.5	27.7	16.9	33.6*	8.9	44.4	3.9	54.7
Manganese (Lumps)[8]	1.2	4.4*	8.7	6.2*	22.4	12.5	23.1	26.1	21.4	33.4	19.9	35.1	13.1	40.4	3.2	53.7*	...	..
Calcium Carbide[9]	1.2	2.4	3.8	4.4	11.9	8.3*	24.4	20.1	24.2	25.5*	16.1	41.2*	9.9	46.8	4.2	57.3	0.6	64.3
Molybdenum (Wire)[10]	0.0	1.0	8.8	3.3*	23.6	9.0	30.1	15.2*	23.5	25.3*	17.3	30.2	9.8	39.7	3.1	49.2	1.6	54.7
Titanium (Lumps)	2.4	2.6*	7.0	2.9	10.5	8.6	28.1	14.9	23.7	25.1	23.5	26.3	11.5	36.1	4.4	50.0*	...	..
Calcium (Turnings)	1.8	0.0	7.8	3.4	28.4	9.3	30.2	15.8	26.7	22.9	15.2	34.9	Calcium melts above 800° C.					
Silicon (Lumps)	8.0	8.9	8.0	2.4	17.0	6.9*	28.1	11.5	25.7	18.8	18.0	27.2	9.6	34.3	2.2	50.9*	...	..
Cobalt (Strips)[11]	2.1	1.8	9.4	3.2	22.3	8.2	29.7	13.0	27.9	18.9*	14.8	43.2*	2.7	56.5*	1.0	60.8*	...	..
Tungsten (Rods)	6.2	2.1	14.9	4.8*	22.4	8.4	29.8	13.4*	27.6	18.3*	17.1	28.5	10.0	35.0	1.8	53.2*	...	..
Platinum (Foil)[12]	2.2	0.5	12.3	5.7*	23.1	8.9	30.2	14.6	30.7	17.6	17.9	25.3	9.4	36.8	6.5	42.1*	2.2	57.8
Gold (Foil)	1.6	3.7*	9.6	3.8	25.2	8.8	31.0	16.0*	25.2	20.8	20.7	23.4*	11.8	34.2*	5.2	46.3	...	..
Silver (Foil)	9.4	2.5	13.0	3.4	20.6	9.8	29.8	14.0	27.4	19.7	21.4	26.6*	10.5	37.1	5.8	43.7*	...	..

* For purposes of reference the observations are all grouped under nine temperatures. Where the actual observed temperature varied more than 5° from that which heads the column, an * marks the fact. The exact temperature may be found by consulting the curves.

[1] Light fog appeared at 610° C. Fog became heavy and brown at 800° C. and almost black at 900° C. Solid material was deposited at this higher temperature instead of liquid tar.

[2] Light fog appeared at 785° C. but soon disappeared. No tar was found in the precipitator, but a very small amount was found in the cool end of the condenser. Naphthalene crystals were found in the cool end of the cracking tube. Pumice was stained black through all the pores and had gained 2 g. in weight, but this could not be removed by heating in air.

[3] Traces of fog visible at times, other conditions similar to (2).

[4] No carbon on gauze at 650° C. Fog began at 740° C. Gauze examined again at 800° C. Surface was tarnished but no free carbon present. Heavy fog above 800° C. Heavy deposit of tar and naphthalene in the tar precipitator.

[5] Gauze changed after each determination as the carbon deposited in one run was sufficient to plug up the tube. No fog visible at any time and no tar.

[6] Remarks for nickel apply here(5).

[7] Heavy fog above 750° C. Considerable tar deposited. No free carbon. The chromium was seemingly unaffected.

[8] Yield of tar small. Some free carbon in cracking tube. The lumps of manganese which were made by the Goldschmidt process crumbled into pieces.

[9] No visible fog at any time. No tar deposited. At the end of run the pieces of calcium carbide were found cemented together by pieces of hard coke.

[10] Heavy fog above 750° C. Good tar deposit. A few hard lumps of coke were found adhering to the wire after two or three runs.

[11] Heavy fog but not much tar. Large amount of carbon in the form of soft lampblack in the cracking tube.

[12] Heavy fog and good tar yield. Platinum was tarnished at end of run but was easily cleaned. No free carbon deposited.

This was checked up so many times that finally this last determination was not carried out above 750° C.

The composition of the olefines will be taken up in a later part of this paper.

In no case where tar was formed during a run did it deposit in noticeable amounts before a temperature of 700° to 750° C. was reached. Slight bluish fogs were sometimes observed earlier, but in no case was tar recovered from them.

The tabulated results are shown above. See also Figs. 4 to 7 inclusive.

DISCUSSION OF RESULTS

In accordance with former work it is observed that a tar is produced by heating straight-chain hydrocarbons of low molecular weight to a temperature of 700° C. and above. This tar has been shown[1] to consist of a mixture of simple aromatic compounds, such as benzene, with more complex ones, such as phenanthrene. With the exception of nickel, iron, and cobalt, metals do not seem to have any great catalytic effect upon the reaction, nor does variation in the surface exposed seem to influence the reaction. It is to be noted in this connection that Bone and Coward[2] found that the decomposition of methane was a surface effect, but the decomposition of ethane and of ethylene was not.

The metals nickel, iron, and cobalt act as anticatalysts, so far as the production of tar is concerned. Their presence causes the main reaction to be of the order

Straight-chain hydrocarbons ⟶ Carbon + Hydrogen

The above reaction always takes place to a certain extent in the thermal decomposition of the hydrocarbons, but in most of the cases examined it is much less important than the reaction

Straight-chain hydrocarbons ⟶
Aromatic hydrocarbons + Hydrogen + Methane

It may also be pointed out here that many of the decompositions observed when a substance was "passed through a red-hot iron tube" may have been due to the specific catalytic action of the iron pipe, particularly in those cases where large amounts of free carbon were produced.

The carbon deposited in these experiments varied from hard, coke-like, and closely adherent material to soft, velvety lampblack (this latter when the three anticatalysts were used) that did not adhere to the tube. Bone and Coward[1] hold that the decomposition of methane gives the hard variety, while ethylene gives the soft material. Our work seems to confirm this, for in those cases where soft carbon was deposited the amount of methane in the gas was small.

THE INFLUENCE OF TEMPERATURE AND OF PRESSURE ON THE PRODUCTION OF AROMATIC HYDROCARBONS

In this part of the experimental work it was first attempted to ascertain at what temperature the maximum yield of tar was obtained, and definitely establish whether any of the catalysts previously used promoted the formation of tar.

The same apparatus was used, with the exception that an improved form of precipitator was used. This is shown in Fig. 2 and is simply a 2 in. tube drawn down on one end to a point which is fitted with a rubber tube and pinchcock. A cylinder of gauze which fits the tube tight was one electrode, the other was simply a fine iron wire insulated by a glass tube. This insulation was necessary to prevent sparking from the center electrode to the gauze. The same 2 in. spark coil was used as a source of current and the whole precipitator was immersed in a freezing mix-

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[1] Zanetti, *Loc. cit.*

[2] *Loc. cit.*

[1] *Loc. cit.*

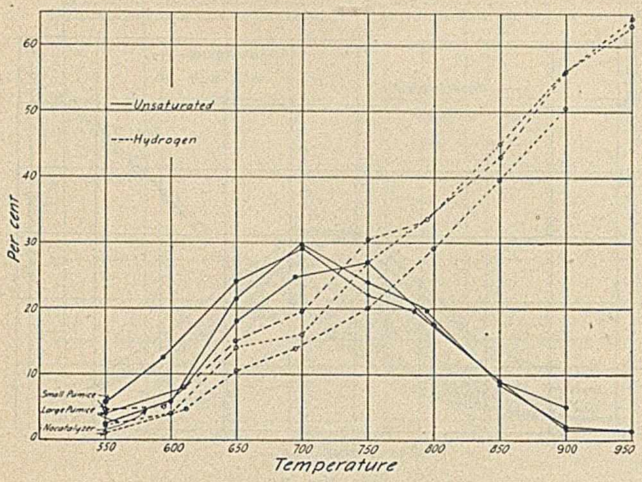

FIG. 4

ture. This precipitator worked so well that it was possible to pass the gas through the cracking tube at a rate of 3 to 4 cu. ft. per hr. and still have complete precipitation of the tar.

PROCEDURE—The furnace was brought up to the desired temperature and the gas admitted at the rate of approximately 1 cu. ft. per hr. The precipitator was started and the apparatus left to itself. At intervals, the temperature and the rate of flow were checked up, and while it was found possible to regulate the temperature within a few degrees, it was not always possible to regulate the rate of flow closer than 5 or 10 per cent of the rate desired. This was chiefly due to the gradual choking of the delivery pipe with naphthalene. At the end of a run the time was noted, the tar run out of the precipitator, its volume measured, and its specific gravity taken at 20° C. No analysis of the tar was attempted. The precipitator and tube were cleaned and a new run made the next day.

A few of the catalyzers which seemed most promising were introduced into the cracking tube, as before, and the yields determined after the most favorable temperature for the formation of tar had been worked out.

No records were made below 750° C., as the yields of tar were negligible.

The results are shown in both tabular and graphic form (Fig. 8).

Temp. Deg. C.	Vol. of Gas Used Cu. Ft.	Length of Run Hours	Vol. of Tar Obtained Cc.	Rate Cu. Ft. Per Hr.	Yield per Cu. Ft.	Sp. Gr.
750	8.2	7.7	16.3	1.06	2.24	0.9819
800	7.6	8.1	25.5	0.94	3.33	1.0040
850	7.9	8.2	42.0	0.96	5.30	1.0600
900(*a*)	7.3	7.2	1.2	1.01	0.16	..
Copper as Catalyzer						
850	8.6	7.2	53.4	1.18	6.2	0.999
Chromium as Catalyzer						
850	7.2	5.4	41.0	1.32	5.7	1.002
Silicon as Catalyzer						
850	6.4	6.1	49.0	1.04	7.7	1.016
Tungsten as Catalyzer						
850	8.6	7.0	45.4	1.23	5.3	1.038

(*a*) In the run at 900° C. a large amount of naphthalene was produced. It deposited on the sides of the precipitator and on the electrodes in such a way that its volume could not be measured.

It is evident from the above that a temperature of 850° C., or thereabouts, is the best for tar formation. The increasing specific gravity of the tar with higher temperatures shows a decreasing content of the lighter aromatic hydrocarbons such as benzene, and also indicates the formation of more complex substances such as naphthalene and phenanthrene. Other work, which is not yet completed, confirms this point.

The use of catalysts seems to give a slightly better yield of tar, but this may be due to the more advantageous transfer of heat to the gas when the packing tube is packed. The specific gravity and the general appearance of the tar resulting from the use of catalysts are also approximately the same as of the tar produced at the same temperature, but without the use of a catalyst.

It seems, therefore, that catalysts have no marked beneficial effect on tar formation from straight-chain hydrocarbons.

In order to gain an insight into the reactions taking place during tar formation it was thought worth while to investigate the effect of pressure on the gaseous products and on the yield of tar.

The effect of diminished pressure as well as increased pressure was studied. For diminished pressure the apparatus already described worked very well, after a few alterations had been made. A manometer for measuring the pressures had to be fitted and a slightly different method of by-passing the gas, when samples were collected, was necessary. The silica tube was entirely unsuited for the pressure work, however, and it was found impossible to heat a copper tube to the required temperatures in the electric furnaces at hand. It was therefore decided to build a furnace using the cracking tube as a core. An iron tube was inadmissible, of course, because of its anticatalytic effect, so copper, although rather soft and of low melting point, was decided upon. It has no catalytic effect and may be readily obtained in any size.

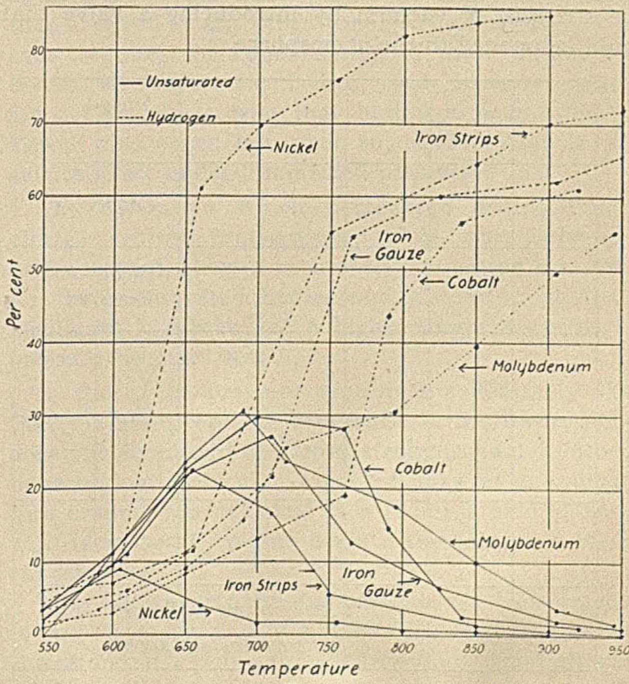

FIG. 5

The construction of the furnace is simple, but a few words of explanation may not be out of place. The tube itself was extra heavy copper pipe, 1 in. in diameter and 3 ft. long. It was found impossible to

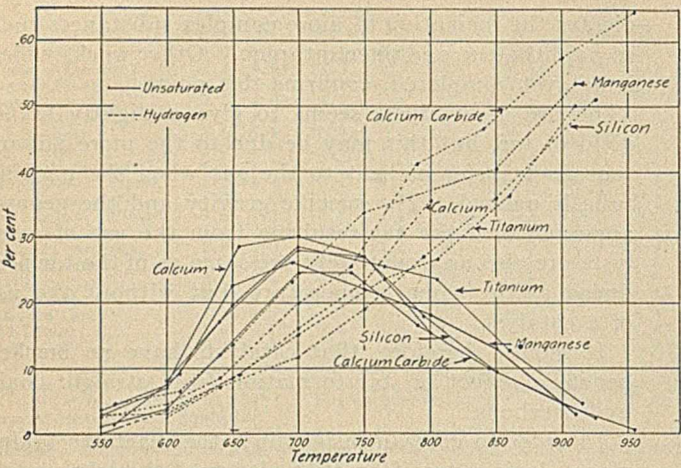

Fig. 6

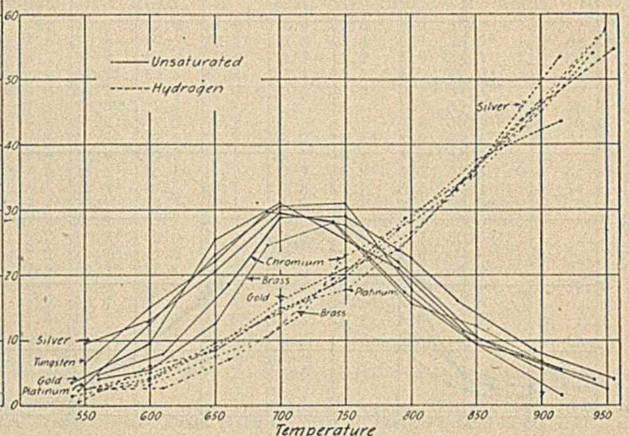

Fig. 7

cut good threads on the ends, so 6-in. sections of heavy brass pipe were brazed on and silver soldered to make a tight joint. These brass ends were threaded and fitted with hydraulic iron fittings and valves. All joints were made tight with litharge-glycerin cement. Twenty-inch strips of $^1/_4$ in. asbestos board were first wired around the pipe, and the nichrome wire wound in two sections on the strips. The ends of the wires were brought out to $^1/_4$ in. asbestos board heads.

The furnace would heat up to 900° C. in 20 min. Beyond that temperature we did not think it advisable to venture.

PROCEDURE—The procedure was about the same as before. The furnace was brought up to temperature, the rate of flow adjusted, and the pressure regulated. Vacuum was obtained by a motor-driven Nelson pump, and arrangement was made for altering the strength of vacuum by introducing a valve that could be opened to the atmosphere.

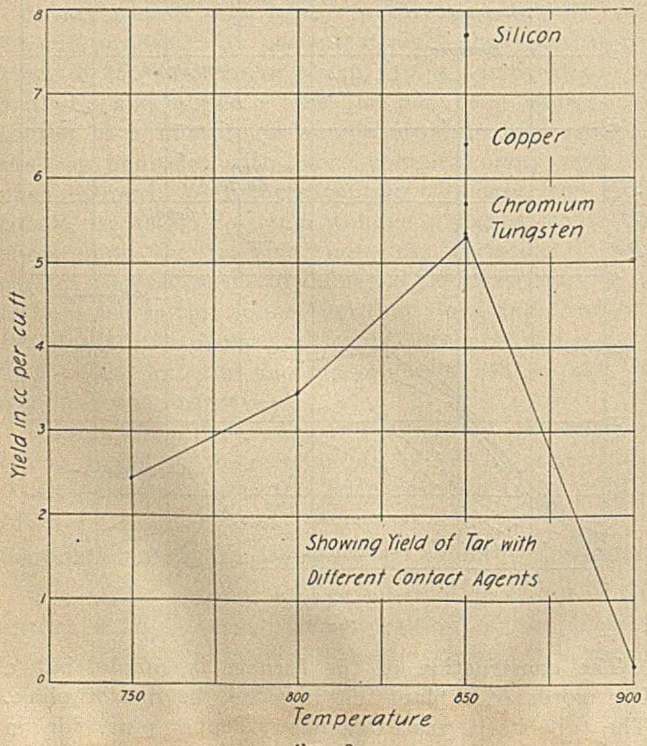

Fig. 8

Pressure was obtained by connecting the furnace directly to the tank of compressed gas through a pressure reduction valve that could be adjusted within a pound or two. An escape valve in the far end of the furnace provided another adjustment. The same runs were made as before and the cracked gas analyzed as described in Part I.

The work of high pressure was taken up first. After the furnace had been brought up to temperature, gas was run through it at atmospheric pressure, a sample taken, and the pressure raised to 25 lbs. While equilibrium was being reached in the furnace the first sample was analyzed. In the same way the pressure was raised to 50, 75, and 100 lbs., the temperature being held constant meanwhile. This usually constituted a day's work. The next day the work was repeated at the next higher temperature until the whole range of temperatures had been recovered. The results may be observed in the following graphs (Fig. 9).

From the results of the work it seems that two entirely different reactions take place in the cracking, and they may be divided into those that take place below 700° C. and those that take place above 700° C.

Up to 700° C. increase of pressure causes increase of unsaturated hydrocarbons and hydrogen in the cracked gas. At 700° C., however, a sharp change is noted, and from that point on increase of pressure *decreases* the amounts of unsaturated hydrocarbons and

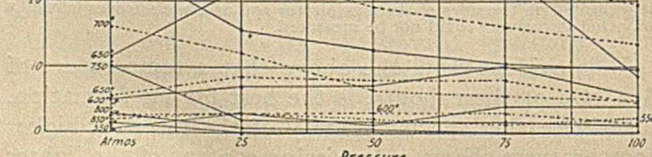

Fig. 9

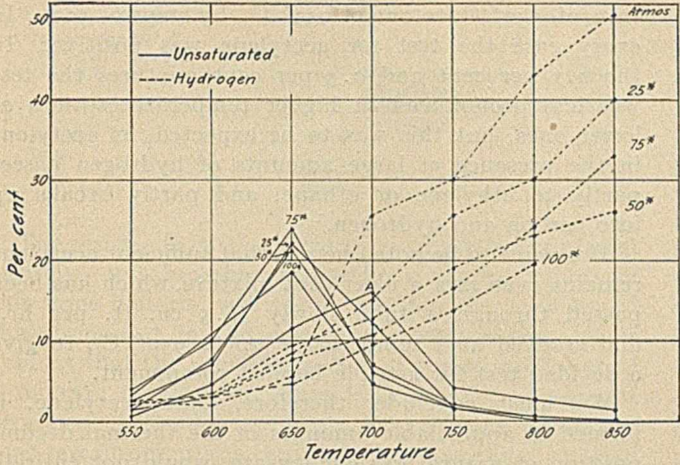

FIG. 10

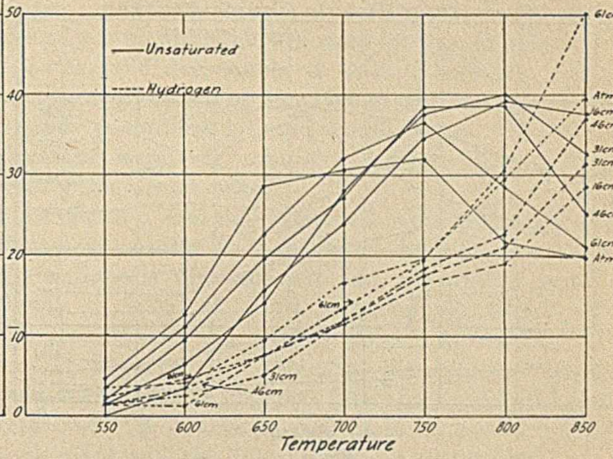

FIG. 11

hydrogen in the cracked gas. There is no doubt that many complex reactions are taking place in the heated tube, but below 700° C. decrease of volume is unquestionably taking place. Above that temperature we have supposed that condensation to aromatic hydrocarbons takes place. This point is well sustained by other writers, but, at the same time, large quantities of hydrogen are split off and much methane is liberated, so the sum total of the reaction is an increase of volume. Pressure therefore should inhibit the reaction.

This view is confirmed by the fact that in all the runs above 700° C. at atmospheric pressure the vapor in the tar precipitator is brown with tar, and tar is deposited as usual. As soon as pressure is applied, however, the vapors become colorless and no more tar is deposited. The first increment of 25 lbs. pressure was sufficient to prevent the formation of tar, in all cases but the last (850° C.), where a slight fog persisted until a pressure of 50 lbs. was reached.

The curves (Figs. 10 and 11) in which percentage composition of the gas is plotted against temperature, the pressure being constant, show great similarity among themselves and with the simple curves representing runs at atmospheric pressure.

In the diminished pressure work, the procedure was the same as above except that the samples had to be taken in a slightly different way, that need not be described here. The temperature was held constant while readings at atmospheric pressure, at 61, 46, 31, and at 16 cm. of mercury were taken. The exact degree of diminished pressure was rather difficult to maintain, but by careful adjustment of a stopcock which permitted access to the atmosphere at one end of a T-tube, the other end being connected to the tar precipitator, this was finally accomplished.

The results (Fig. 12) bear out in detail those obtained with increased pressure. As the pressure becomes less, the content of unsaturated hydrocarbons and of hydrogen in the cracked gas becomes less at all temperatures up to 700° C. This time 750° seems to be the transition point, the percentage of hydrogen falling slightly while the percentage of olefines increases somewhat. Thereafter the percentage of hydrogen decreases rapidly with diminished pressure while the percentage of unsaturated hydrocarbons increases correspondingly.

Tar made its appearance at 750° C., but diminished with the pressure. Very little tar was deposited at any temperature under diminished pressure, which may be due to two things. Under conditions of diminished pressure the gas is not exposed to the effect of heat as long as it is under atmospheric pressure. On the other hand, the formation of tar is a condensation, and as such would be impeded by diminished pressure. The point brought out is that the formation of tar takes place in two stages.

The first one involves splitting of the saturated bodies into unsaturated bodies, with the splitting out of hydrogen and consequent increase of volume. Diminished pressure accelerates this stage and in one case the percentage of unsaturated hydrocarbons rises as high as 39 per cent, which is considerably more than attained at any other time. The next step, however, requires the condensation of these unsaturated bodies into aromatic bodies, and pressures should favor this. It is true that hydrogen may split out also at this point, but, even so, condensation is difficult to effect under diminished pressure.

The curves in which percentage composition is plotted against temperature, while the pressure is held constant, show a constantly increasing maximum for the unsaturated bodies and also show that this maximum is reached at a higher temperature as the pressure becomes less.

In short, the pressure experiments definitely show that the main reaction concerned in the formation of aromatic hydrocarbons from straight-chain hydrocarbons of low molecular weight begins at a temperature around 700° C., and is a reaction that proceeds with increase of volume despite the fact that it is a condensation.

They show, furthermore, that the reaction proceeds in two steps, the first of which is impeded by pressure, the second of which is impeded by diminished pressure. Diminished pressure, however, largely increases the yield of unsaturated hydrocarbons, and as these will later be shown to be valuable substances, a new way is opened for the production of these bodies in large amounts.

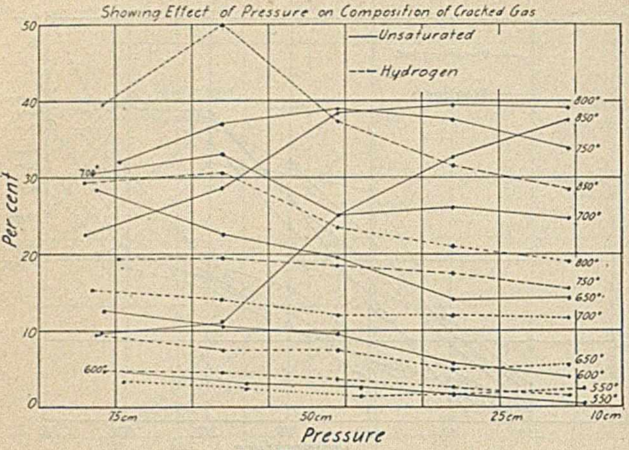

FIG. 12

THE REACTION

SIMPLE STRAIGHT-CHAIN HYDROCARBONS ⟶ AROMATIC HYDROCARBONS

There are two views held concerning the formation of aromatic bodies from the straight-chain series. The theory claiming the largest number of adherents is the decomposition of the saturated hydrocarbons step by step to acetylene, which then polymerizes to benzene.[1]

The other view holds that aromatic bodies can be formed from olefine bodies directly without going through the acetylene stage.[2] It must be admitted that little experimental evidence has been produced to substantiate this latter view, the chief reliance being placed in the fact that it has been impossible to detect acetylene at any stage of the reaction. It was decided to investigate the reaction concerned in this work, with the hope that we could fit it to one or the other of these views.

The evidence of the polymerization of acetylene to benzene is incontrovertible, so this work was not repeated. The work was therefore begun by mixing known amounts of acetylene with the gas used in our previous work. This was accomplished by passing a definite amount of acetylene through the referee meter into an empty gas holder, following this by the addition of sufficient natural gas condensate to make up a mixed gas of desired acetylene content. The mixture was allowed to stand a day before being used, that thorough mixture might take place. It was then run through the cracking tube in the original apparatus and the cracked gas allowed to bubble through ammoniacal silver nitrate, followed by ammoniacal cuprous chloride.

The following mixtures were experimented with:

	Per cent		Per cent
Acetylene	0.1	Natural Gas Condensate	99.0
Acetylene	0.5	Natural Gas Condensate	99.5
Acetylene	1.0	Natural Gas Condensate	99.0
Acetylene	2.5	Natural Gas Condensate	97.5
Acetylene	5.0	Natural Gas Condensate	95.0
Acetylene	10.0	Natural Gas Condensate	90.0

As the mixed gas was led through the cracking tube, the temperature was raised from an initial temperature of 550° C. to one of 950° C., by steps of 50°. In every case the test for acetylene was positive. In the 0.1 per cent and 0.5 per cent mixtures the test was less pronounced at higher temperatures than at lower ones, but this was to be expected, as acetylene in the presence of large amounts of hydrogen passes partly to ethylene or ethane, and partly breaks up into carbon and hydrogen.[1]

The point to be noted here is that sufficient acetylene remains even in a 0.1 per cent mixture, which has been passed through a tube slowly (0.5 cu. ft. per hr.) and cracked at a temperature up to 950° C., to give a decided test for a triple bonded component.

We must conclude, therefore, that acetylene, if formed in appreciable amounts in the thermal decomposition of natural gas condensate, would not entirely decompose again. In any event, enough would remain to give a reaction with silver nitrate or cuprous chloride. Although the absence of acetylene has been reported in this connection, we repeated the tests, using clean gas, and could find no trace of acetylene.

Examination of the bromides formed by passing the cracked gas through bromine under water and cooled with ice and salt showed no tetrabromacetylene.

The absence of acetylene or other triple bonded hydrocarbons seems to establish the fact that aromatic formation is not in this case dependent upon their formation.

In order to study the unsaturated bodies more thoroughly, about 500 g. of mixed bromides were prepared as described above.

It has been pointed out before that methane was the only hydrocarbon remaining when the gas was cracked at a temperature of 750° C., or above, so simple bromides of ethane or propane need not be looked for. In order to make certain that substitution was not taking place in the methane, however, a preliminary experiment was run in which the bromine was used dissolved in carbon tetrachloride. Hydrobromic acid is given off from such a solution when substitution takes place as opposed to addition. The gases, after passing through the bromine solution, were cooled to —20° C., and then passed through glass wool at the same temperature to catch any volatilized bromine vapor. They were then allowed to bubble through standard potassium hydroxide. Back titration showed that almost no acid had come over, and therefore that substitution was not taking place to any appreciable extent.

The 500 g. of mixed bromides prepared above were distilled under 4 cm. vacuum with the following results:

	Volume Per cent	Sp. Gr.
1st drop at 29° C.	...	...
29°–50°	6.5	1.46
50°–60°	35.0	1.89
60°–64°	45.0	2.13
Residue	10.0	...
Loss	3.5	
	100.0	

No trouble was experienced in the distillation, as decomposition of the bromides did not take place. The liquid distillates were then mixed and redistilled at atmospheric pressure with the following results:

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[1] Berthelot, *Ann. chim.*, [4] **9**, 469.

[2] D. T. Jones, "The Thermal Decomposition of Hydrogenated Hydrocarbons," *J. Chem. Soc.*, **107** (1915), 1582, and "The Thermal Decomposition of Low Temperature Coal Tar," *J. Soc. Chem. Ind.*, **36** (1917), 3.

[1] Bone and Coward, *Loc. cit.*

Temperature	Volume Per cent		Sp. Gr.
1st drop at 89° C.	...		...
89°–125°	10.3		1.492
125°–133°	44.7	Ethylene Bromide Fraction	2.108
133°–137°	12.8	Propylene Bromide Fraction	2.070
Residue	29.4		...
Loss	2.8		
	100.0		

The residue from the vacuum distillation was almost entirely tetrabrombutane, while a large amount of this same material was extracted from the thick liquid that remained in the distillation flask above. It is evident that the bromides are, as reported by Zanetti,[1] a mixture of ethylene bromide, a smaller amount of propylene bromide, and from 10 per cent to 20 per cent tetrabrombutane (butadien tetrabromide). Small amounts of other bromides are also present, but no acetylene tetrabromide (b. p. 137° C., sp. gr. 2.9) was found. The bromine content of the ethylene and propylene bromides was checked up by analysis and found to be correct within 0.5 per cent. The melting point of the tetrabrombutane was found to be 117° C. (correct value = 118° C.) and its bromine content corresponded to the formula $C_4H_6Br_4$.

The source of the tetrabrombutane needs inquiry. But very little butane exists in the original gas, which, as remarked before, consists of almost nothing but ethane and propane. The butane content is not large, and accounts in no way for the large yield of tetrabrombutane. A building-up process must therefore be responsible for the greatest part of the yield. It is a known fact that butadien yields tetrabrombutane on bromination and, since the presence of this compound was suspected, experiments were carried out to isolate it.

In order to prove this point, the gases, after cracking at 850° C., and after all the tar was removed by the precipitator, were cooled down in three stages. The cleaned gas was slowly led through three wide test tubes placed in thermos bottles containing cooling liquids. In Tube 1, the gas was cooled to —3° C. Any benzene still present was frozen out in this tube. Tube 2 was kept at a temperature of —90° C. by means of a mixture of alcohol and liquid air, while Tube 3 was placed in liquid air direct. The temperature of the gas in this last tube was about —170° C.

The boiling points of some of the substances we are dealing with are given as follows:

Methane	—164°	Propylene	— 50°
Ethane	— 89°	Butylene	— 5°
Propane	— 39°	Butadien	— 5°
Butane	+ 0.6°	Hydrogen	—256°
Ethylene	—103°	Benzene, f. p.	+ 5°

Ethane, propane, and butane can be ruled out at once, as methane is the only saturated hydrocarbon remaining in the gas at this temperature. Assuming all the rest of the gases to be present, it is evident that only benzene will be deposited in Tube 1. Propylene, butylene, and butadien will condense in Tube 2, while ethylene and some methane will condense in Tube 3. Hydrogen mixed with a large amount of the vapor of methane will pass on uncondensed.

Some solid did appear in Tube 1, showing that the precipitator does not remove all the benzene; Tubes 2 and 3 contained liquid condensates. These condensates were very mobile, almost colorless liquids with pronounced odors.

In Tube 2 we are concerned with the presence of butadien, so after 20 to 30 cc. of liquid had collected, the tube was disconnected and allowed to warm up slowly to —20° C. The propylene all boiled off in the process and the volume shrunk to less than one-half. Keeping the tube in the cooling mixture, pure bromine was dropped into the liquid which still remained. A reaction of almost explosive violence took place and the liquid began to boil rapidly.

Addition of bromine was continued until the liquid remained slightly red, then a little liquid from Tube 3 was added to combine with the excess bromine. About half the liquid remaining, after the propylene had boiled off, was lost in the bromination process which had generated enough heat to keep the bromides formed liquid for some time, even though the bath was still at a temperature of —20° C. Shortly afterward, however, the whole residue in the test tube solidified. The tube was withdrawn, a portion of the crystals recrystallized from alcohol, and the melting point determined. M. p. = 117° C. No butane dibromide, which would result from the presence of butene, was observed.

This experiment was repeated, but this time after 30 to 40 cc. of liquid had collected in Tube 2, it was disconnected and closed with a stopper and delivery tube, whose end was beneath bromine covered with water and cooled with a mixture of ice and salt. The gases evolved as Tube 2 warmed up to —20° C. were allowed to bubble through the bromine until the temperature of —20° C. was reached. Another tube containing bromine was then substituted for the first one and Tube 2, containing the condensed gas, was removed from the thermos bottle and allowed to come to room temperature, the evolved gases passing through the bromine as before. All the liquid in the tube had vanished before a temperature of —2° C. was reached.

By distillation, propylene bromide was readily obtainable from the first tube of bromine as a heavy, almost colorless liquid, with a pronounced and rather sweet odor, b. p. = 139.8° C., sp. gr. = 1.942 at 17° C. The liquid in the second tube solidified and was identified by its melting point as tetrabrombutane.

Tube 3 was now disconnected from the apparatus and transferred to a thermos bottle containing a mixture of liquid air and alcohol at a temperature of —115° C. Violent ebullition took place as it warmed up to this temperature, and methane (b. p. = —164° C.) boiled off. A clear liquid remained which was practically all ethylene. It was identified by brominating a small portion of it and taking the melting point (m. p. = +9° C.).

The experiment was repeated once more, but this time, after the propylene had boiled off Tube 2 and

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[1] *Loc. cit.*

the methane off Tube 3, the remaining material as it volatilized was led in each case to a small gasometer. The gas so obtained represented a mixture of approximately 30 per cent butadien and 70 per cent ethylene.

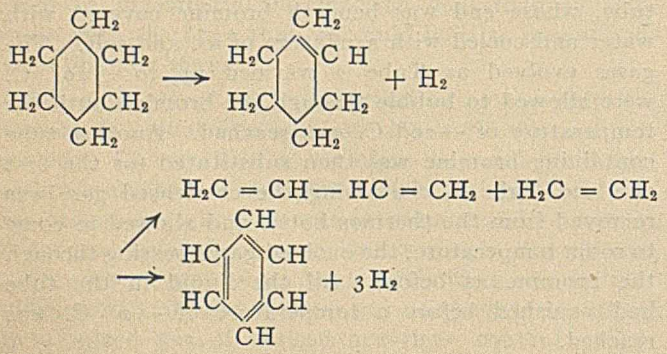
This mixed gas was passed through the original apparatus and cracked at a temperature of 850° C. A small amount of tar similar in all respects to the original tar was obtained. Its specific gravity was 1.010. Further analysis was not attempted, owing to the small amount formed. The cracked gas was then analyzed and shown to be 50 per cent unsaturated, 20 per cent methane, and 30 per cent hydrogen. The cracked gas, when cooled down as before, gave a large amount of ethylene in Tube 3 along with some ethane. Tube 2 had only a trace of condensate, showing that all the butadien had combined.[1]

CONCLUSIONS

The presence of butadien in large quantities in the cracked gas can be explained only by the combination of two molecules of ethylene, with the splitting off of hydrogen, thus

$$H_2C = CH_2 + H_2C = CH_2 \longrightarrow H_2C = CH - HC = CH_2 + H_2$$

If now we presume that another molecule of ethylene can unite with the butadien, we have all the necessary steps for the formation of benzene. D. T. Jones[2] finds that cyclohexane on heating to 500° C. passes to cyclohexene which then decomposes in two ways, yielding benzene on one hand and butadien with ethylene on the other.



The present work merely requires the union of the ethylene and butadien of this equation to form cyclohexane which most likely has no separate existence, breaking down at once into benzene and hydrogen. This reaction involves an increase of volume and would therefore be inhibited by increase of pressure, a fact which has already been proved true above.

In support of these views we have the work of Jones,[2] who inclines to the belief that olefines condense to aromatic bodies. He states, "It is highly probable that a necessary transient stage is the formation and condensation of the stable conjugated double linking, —CH = CH — CH = CH—." The presence of this linkage in its simplest form, butadien, has been demonstrated above.

Staudinger,[1] starting with isoprene, showed that 45 to 55 per cent of this material was converted into a tar by passing it through a tube at 750° C. This tar contained aromatic hydrocarbons similar to those Zanetti found in his tar. Staudinger also cracked butadien alone and obtained from it a tar that contained about 25 per cent benzene.

It seems to be established, therefore, that diolefines, on cracking, pass in large part to closed chain bodies. It has been demonstrated in this work that simple olefines and diolefines are produced by the cracking of the ethane-propane fraction of natural gas condensate. The aromatic bodies found in the tar comes from the condensation of the diolefines and this therefore gives us all the necessary steps in the formation of aromatic bodies from straight-chain hydrocarbons of less than four carbon atoms, and without the necessity of passing through the stage of acetylene.

SUMMARY

I—It has been shown that most metals are without action on the reaction

Paraffin hydrocarbons ⟶ Aromatic hydrocarbons.

The metals nickel, iron, and cobalt are anticatalysts for the above reaction, but promote to a marked degree the reaction

Paraffin hydrocarbons ⟶ Carbon + Hydrogen.

II—The effect of temperature and pressure on the production of aromatic hydrocarbons has been studied. It has been pointed out that a temperature of 850° C. is most favorable for the formation of liquid tar and that the formation of complex aromatic bodies increases with the temperature.

III—Increase of pressure inhibits the formation of tar while diminished pressure increases the yield of unsaturated bodies but also decreases the actual yield of tar.

IV—Butadien has been isolated in fairly large amounts from the unsaturated bodies produced in the thermal decomposition of natural gas condensate.

V—Acetylene has been shown to be without action in the formation of the aromatic compounds.

VI—Tar containing aromatic bodies has been produced from the cracking of a mixture of butadien and ethylene.

VII—The most probable reaction for the formation of aromatic bodies from natural gas condensate is

Saturated straight-chain hydrocarbons (Ethane) ⟶ Simple olefines (Ethylene) ⟶

Higher olefines with conjugated bonds (Butadien) ⟶ Aromatic hydrocarbons (Benzene)

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[1] For references on the preparation and properties of butadien see *J. Chem. Soc.*, **27** (1874), 406; *J. Chem. Soc.*, **49** (1886), 80; and *Ann.*, **308** (1899), 333.

[2] *Loc. cit.*

[1] *Ber.*, **46** (1913), 2466

LABORATORY AND PLANT

METHODS OF ANALYSIS USED IN THE COAL-TAR INDUSTRY. III—HEAVY AND MIDDLE OILS

By J. M. Weiss

Received September 9, 1918

HEAVY OIL TESTS

TEST H2—WATER[1]

APPARATUS—Same as given under B2 (see Fig. II, Paper I, This Journal, **10** (1918), 735).

METHOD—200 cc. of oil shall be measured in a graduated cylinder, and poured into a copper still, allowing the cylinder to drain into the still for several minutes. Attach lid and then the clamp, using a paper gasket slightly wet with oil, around the flange of the still. Heat shall be applied by means of the ring burner, which shall be placed just above the level of the oil in the still at the beginning of the test, and gradually lowered when most of the water has distilled over. The distillation shall be continued until the vapor temperature, indicated by the thermometer with the bulb opposite the off-take of the connecting tube, reaches 205° C., the distillate being collected in the separatory funnel. When the distillation is completed, and a clear separation of water and oil in the funnel has taken place, the water shall be read by volume and drawn off; and any light oil distilled over with the water shall be returned to the oil in the still after it has cooled sufficiently. The dehydrated oil from the still shall be used for the distillation and other tests.

TEST H3—SPECIFIC GRAVITY (SPINDLE)[1]

APPARATUS—Hydrometer and cylinder (See Fig. II, Paper I, This Journal, **10** (1918), 735). Two hydrometers with ranges 1.00 to 1.08 and 1.07 to 1.15 will suffice. These shall be calibrated at 15.5° C. (60° F.).

METHOD—The oil shall be brought to a temperature of 38° C. (100° F.) and the determination shall be made at that temperature unless the oil is not entirely liquid at 38° C. The cylinder shall be filled with dry oil, the latter stirred, and the temperature noted. The hydrometer shall be inserted and the reading taken. In case the oil requires to be brought to a higher temperature than 38° C. in order to render it completely fluid, it shall be tested at the lowest temperature at which it is completely fluid, and a correction made by adding 0.00075 to the observed specific gravity for each degree Centigrade above 38°, at which the test is made.

PRECAUTIONS—Before taking the specific gravity the oil in the cylinder should be stirred thoroughly with a glass rod, and this rod when withdrawn from the liquid should show no solid particles at the instant of withdrawal. Care should be taken that the hydrometer does not touch the sides or bottom of the cylinder when the reading is taken, and that the oil surface is free from froth and bubbles.

ACCURACY—0.002.

NOTE—The correction factor, 0.00075, does not apply with equal accuracy to all oils, but serious error due to its use will be avoided if the precaution of avoiding unnecessarily high temperature is observed.

The factor 0.00075 and its method of use are approximations.

TEST H4—SPECIFIC GRAVITY (WESTPHAL)

APPARATUS—Westphal balance. 25 cc. glass cylinder.

METHOD—The balance shall be set up and adjusted so that the plummet when suspended to swing freely in air exactly balances the beam. A reading shall then be taken in water at 15.5° C. and if the balance is properly made and adjusted, this will be unity. A second reading in oil at 15.5° C. gives the specific gravity directly.

PRECAUTIONS—If the reading in water at 15.5° C. is not unity when the balance is adjusted in air so that the plummet balances the beam, the balance shall not be adjusted in water, but the oil reading divided by the water reading shall be taken as the specific gravity.

Boiled distilled water shall be used. Care shall be taken to see that the wire from which the plummet is suspended is immersed in both oil and water to the same point when the instrument is in balance. Care must be taken to see that the plummet is clean and dry before immersion.

NOTE—If the specific gravity is to be taken at a temperature above 15.5° C., a reading must be taken in water at the same temperature and the specific gravity at $t/t°$ C. obtained. This may be converted into specific gravity at $t°/15.5°$ C. by multiplying by the density of water at $t°/15.5°$ C. These density figures for water may be found in reference books such as Van Nostrand's Chemical Annual. To calculate from 38°/38° to 38°/15.5° C. the factor is 0.99385. From the foregoing it will be readily seen that it is incorrect to calculate the specific gravity at 38°/15.5° by dividing the reading in oil at 38° by the reading in water at 15.5° C. as is occasionally done.

TEST H5—INSOLUBLE IN BENZOL[1]

All matter as to apparatus, method, notes, and precautions as given under B7[2] apply to this test on these materials.

ACCURACY—0.2 per cent.

NOTE—At least 10 g. of oil shall be taken for the test.

TEST H6—RETORT DISTILLATION[1]

APPARATUS—Retort: This shall be a tubulated glass retort of the form and approximate dimensions shown in Fig. XII with a capacity of 250 to 290 cc. The capacity shall be measured by placing the retort

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[1] See A. S. T. M. Method D-38-17, A. S. T. M. Standards adopted in 1917

[1] See A. S. T. M. Method D-38-17, A. S. T. M. Standards adopted in 1917.

[2] This Journal, **10** (1918), 736.

with the bottom of the bulb and the end of the off-take in the same horizontal plane, and pouring water into the bulb through the tubulature until it overflows the off-take. The amount remaining in the bulb shall be considered its capacity.

Condenser tube: This shall be a suitable form of tapered glass tubing of the following dimensions:

Diameter of small end, 12.5 mm.; permissible variation, 1.5 mm.
Diameter of large end, 28.5 mm.; permissible variation, 3.0 mm.
Length, 360.0 mm.; permissible variation, 4.0 mm.

Shield: An asbestos shield of the form and approximate dimensions shown in Fig. XII shall be used to protect the retort from air currents and to prevent radiation. This may be covered with galvanized iron, as such an arrangement is more convenient and more permanent.

Receivers: Erlenmeyer flasks of 50 to 100 cc. capacity are the most convenient form.

Thermometer: This shall conform to specification as given under C7.

Assembly: The retort shall be supported on a tripod or on rings over two sheets of 20-mesh gauze, 6 in. square, as shown in Fig. XII. It shall be connected to the condenser tube by a tight cork and the thermometer inserted in a tight cork in the tubulature, with the bottom of the bulb $^1/_2$ in. from the surface of the oil in the retort. The exact location of the thermometer bulb shall be determined by placing a vertical rule graduated in divisions not exceeding $^1/_{16}$ in. back of the retort when the latter is in position for the test, and sighting the level of the liquid and the point for the bottom of the thermometer bulb. The distance from the bulb of the thermometer to the outlet end of the condenser tube shall be not more than 24 nor less than 20 in. The burner shall be protected from draughts by a suitable shield or chimney (see Fig. XII).

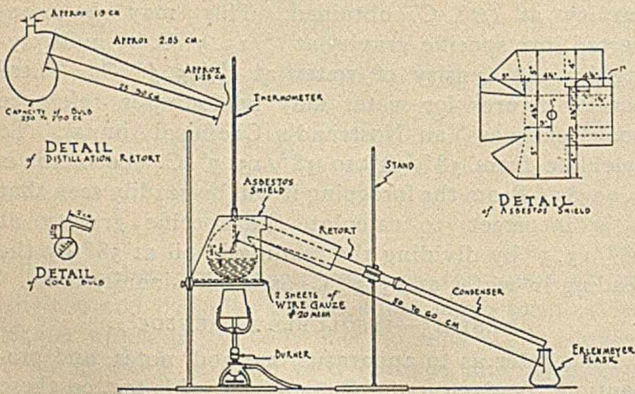

FIG. XII—ASSEMBLY OF DISTILLATION TEST FOR HEAVY OIL
A. S. T. M. D-38-17

METHOD—Exactly 100 g. of oil shall be weighed into the retort, the apparatus assembled, and heat applied. The distillation shall be conducted at the rate of at least one drop and not more than two drops per second, and the distillate collected in weighed receivers. The condenser tube shall be warmed whenever necessary to prevent accumulation of solid distillates. Fractions shall be collected at the following points: 210°, 235°, 270°, 315°, and 355° C. The receivers shall be changed as the mercury passes the dividing temperature for each fraction. When the temperature reaches 355°, the flame shall be removed from the retort, and any oil which has condensed in the off-take shall be drained into the 355° fraction.

NOTES—The residue shall remain in the retort with the cork and the thermometer in position until no vapors are visible; it shall then be weighed. If the residue is to be further tested, it shall then be poured directly into the brass collar used in the float test or into a tin box and covered and allowed to cool to air temperature. Care must be taken not to pour at a temperature high enough to cause loss of oil vapors. If the residue becomes so cool that it cannot be poured readily from the retort, it shall be re-heated and completely melted by holding the bulb of the retort in hot water or steam and not by the application of a flame.

For weighing the receivers and fractions, a balance accurate to at least 0.05 g. shall be used.

During the progress of the distillation the thermometer shall remain in its original position. No correction shall be made for the emergent stem of the thermometer.

When any measurable amount of water is present in the distillate it shall be separated as nearly as possible and reported separately, all results being calculated on the basis of dry oil. When more than 2 per cent of water is present, water-free oil shall be obtained by separately distilling a larger quantity of oil, returning to the oil any oil carried over with the water, and using dried oil for the final distillation (see H2).

TEST H7—SPECIFIC GRAVITY FRACTIONS (WESTPHAL)[1]

APPARATUS—A special type of Westphal balance is obtainable, designed for testing very small quantities. However, the ordinary type of Westphal balance can be adapted to testing small fractions by the use of a special plummet. The plummet can readily be made in the laboratory from a piece of ordinary glass tubing 7 mm. outside diameter, sealed at the end, and melting into the glass, where sealed, a short platinum wire. After cooling place 9 to 10 g. of mercury in the tube, making a column 35 to 40 mm. high. Seal off the tube within 20 mm. of the top of the mercury column with blowpipe flame. The plummet shall have a length of about 55 to 60 mm. over all and shall weigh between 10 and 12 g.

METHOD—The weights necessary to balance the plummet in air and in water of the required temperature shall be noted and similarly the weight necessary to balance the plummet in oil at the same temperature.

If a = weight to balance in air
b = weight to balance in water to $t°$
c = weight to balance in oil at $t°$

$$\text{Specific gravity } t°/t° = \frac{c - a}{b - a}$$

PRECAUTIONS—When using the small plummet, special care is needed that the adjustment of the balance be accurately made.

NOTE—For corrections from $t°/t°$ C. to $t°/15.5°$ C., see note under H4.

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[1] See paper by J. M. Weiss, THIS JOURNAL, 7 (1915), 21, and A. S. T. M. Method D-38-17, A. S. T. M. Standards adopted in 1917.

This method is adapted to fractions which are liquid under 60° C. and may usually be applied to the 235° to 315° fraction.

TEST H8—SPECIFIC GRAVITY FRACTIONS (PLATINUM PAN)[1]

All matter under B6[2] applies to this test on this material.

NOTE—This method is adapted to solid and semi-solid fractions such as are usually obtained from 315° to 355° C.

TEST H9—FLOAT TEST ON RESIDUE[3]

All matter as to apparatus, method, precautions and notes, as given under C8, applies to this test on these materials.

TEST H9—FLOAT TEST ON RESIDUE MATERIAL[3]

All matter as to apparatus, method, precautions and notes as given under C8 applies to this test on these materials.

TEST H10—COKE[4]

APPARATUS—Hard glass bulbs as shown in Fig. XII shall be used.

METHOD—The bulb shall be warmed slightly to drive out all moisture, cooled in a desiccator, and weighed. Then the bulb shall be heated again by placing it momentarily in an open Bunsen flame, the tubular placed underneath the surface of the oil to be tested, and the bulb allowed to cool until sufficient oil is sucked in to fill the bulb about two-thirds full.

Any globules of oil sticking to the inside of the tubular shall be drawn into the bulb by shaking, or expelled by slowly heating it. The outer surface shall be carefully wiped off and the bulb reweighed. This procedure will give about 1 gram of oil.

A strip of thin asbestos paper about 1/4 in. wide and about 1 in. long shall be placed around the neck of the bulb and the two free ends caught close up to the neck with a pair of crucible tongs. The oil shall then be distilled off as in making ordinary oil distillation, starting with a very low flame and conducting the distillation as fast as can be maintained without foaming.

When oil ceases to come over, the heat shall be increased until the highest temperature of the Bunsen flame is attained, the whole bulb being heated red-hot until the evolution of gas ceases, and any carbon sticking to the outside of the tubular is completely burned off. The bulb shall then be cooled in a desiccator, weighed, and the percentage of coke residue calculated on water-free oil.

PRECAUTIONS—Be careful to heat the oil slowly at the start to avoid spurting. If the oil contains over 2 per cent of water it should be dried before testing. The oil must be thoroughly liquefied and uniform throughout.

NOTES—A large diameter cork with a cup-shaped hole cut in the center forms a convenient holder in which to weigh the bulb. When a stock of bulbs is received, one or more should be given a heat test to determine hardness. Occasionally bulbs have been found too soft, therefore melting below the temperature required to coke the oil and thus producing low results.

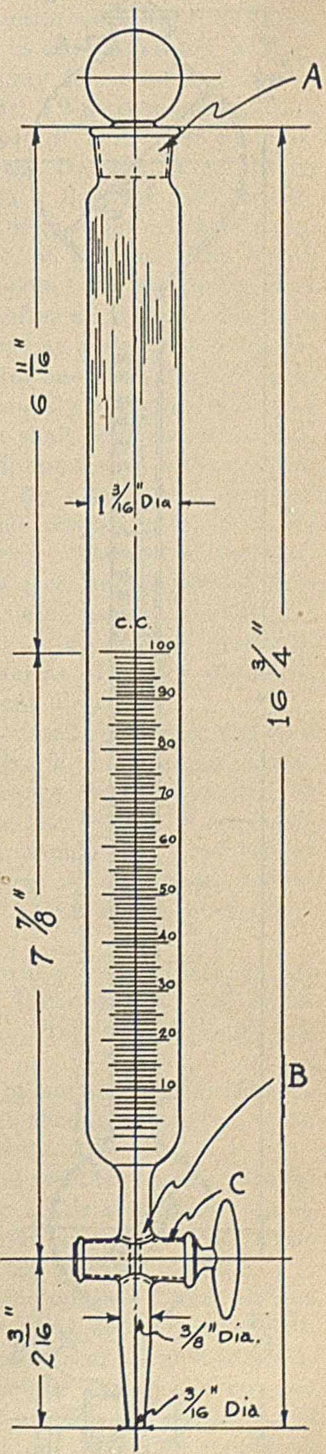

Fig. XIII—Detail of Tar-Acid Separatory Funnel, Type 1

A—Ground glass stopper

B—Capacity given from stopcock up

C—Ground glass stopcock

TEST H11—TAR ACIDS (CONTRACTION METHOD)

APPARATUS—Tar-acid separatory funnel, type 1 (see Fig. XIII). Tar-acid separatory funnel, type 2 (see Fig. XIV). Distillation apparatus.

METHOD—100 cc. of oil shall be placed in a distilling apparatus such as is used under test F5 and distilled until at least 95 per cent of distillate has been obtained or until the vapor temperature has reached 400° C. The entire distillate shall be transferred to a tar-acid separatory funnel—type 1 designed for oils which have 25 per cent tar acids or over, or type 2 for oils containing less than this amount. The funnel with the oil shall be placed in a water bath and kept at a constant temperature of 60° C. until no change in volume takes place. It shall then be extracted with successive portions of 50 cc. each of 10 per cent caustic soda solution until no further diminution in volume occurs. The soda shall be added to the oil, the whole thoroughly shaken, then returned to the bath at 60° C. and allowed to settle completely. After settling is complete, the soda layer shall be drawn off and the volume of residual oil noted. When the point of no further contraction is reached the diminution in volume of the oil shall be considered as tar acids.

NOTES—In some cases (such as creosote tar solutions containing small amounts of acids), there will be insufficient material to bring the oil up into the

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[1] See paper by J. M. Weiss, This Journal, 7 (1915), 21, and A. S. T. M. Method D-38-17, A. S. T. M. Standards adopted in 1917.

[2] This Journal, 10 (1918), 736.

[3] See standard method of the Am. Wood Pres. Assoc. adopted in 1916 and A. S. T. M., D-38-17, tentative method, A. S. T. M. Proceedings 1917, Part 1, p. 826.

[4] *Ibid.*, p. 828.

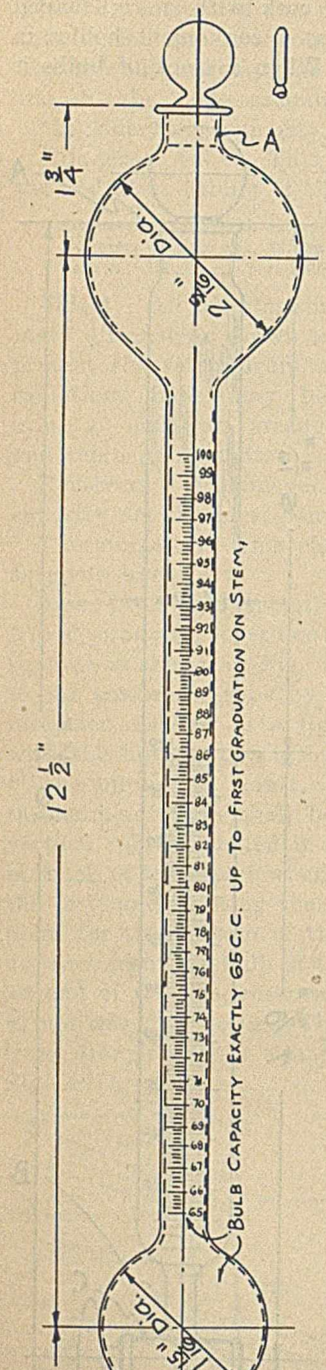

FIG. XIV—SEPARATORY FUNNEL FOR ACID DETERMINATION, TYPE 2

A—Ground glass stopper
B—1/8 in. drilled hole
C—Ground glass stopcock

graduated section of type 2 separatory funnel. In such cases, sufficient tar-acid-free, clean, heavy naphtha may be added to dilute the oil and bring it within the graduated portion. If this is done, the extracted oil cannot be used for subsequent dry salt tests but an additional portion must be extracted for this purpose.

This test is recommended for all general work in oil specifications and general comparative tests, but gives results slightly higher than the true tar-acid content of the oil. The reason for this is that soda withdraws from creosote oil certain compounds which are not subsequently liberated from the soda solution in the form of an oil. These substances are evidently acid in nature but not phenolic bodies.

TEST H12—TAR ACIDS (LIBERATION METHOD)

APPARATUS—Same as used under H11. Water and tar separatory funnel (see Fig. II, Article I, THIS JOURNAL, **10** (1918), 735.

METHOD—100 cc. of oil shall be distilled as prescribed under H11. (Where the content of tar acids is very low, a distillation may be made on 200 cc. so as to obtain a more accurate test.) The oil shall be shaken in a separatory funnel with successive 50 cc. portions of 10 per cent caustic soda or until no more tar acids are removed. The well-settled separated carbolate shall be acidified in a small beaker with 40 per cent sulfuric acid, taking care to keep the mixture cool at all times. (If the content of tar acids is under 5 per cent, use the water in tar separatory funnel and measure carefully into it 10 cc. of "Hiflash" naphtha. The liberated tar acids and sulfate solution are then poured through this layer of naphtha several times, drawing the material off at the bottom of the funnel into the original beaker and pouring it back into the top of the funnel. This washes out the beaker and allows all the tar acids to be absorbed by the naphtha.) The funnel shall then be allowed to stand until the layers separate perfectly clearly when the sulfate solution shall be drawn off and the increase in volume of the naphtha taken as the dry tar acids present. When the content of acids is over 5 per cent, the same procedure can be used, measuring 65 cc. of "Hiflash" naphtha into the tar-acid separatory funnel, type 2.

PRECAUTION—All results must be figured on the basis of dry oil.

NOTES—In distilling 200 cc. of oil, it is necessary to use a distilling bulb of about 500 cc. capacity. "Hiflash" naphtha may be obtained from The Barrett Company Chemical Department.

This method gives approximately the amount of tar acids that can be recovered from an oil in practice.

Results by this method are usually about 90 per cent of the results obtained by the method as given under H11.

TEST H13—HEMPEL DISTILLATION[1]

APPARATUS—Forest Service Hempel flask.[2] Condenser tube (see Fig. II, Article I, THIS JOURNAL, **10** (1918), 735). Thermometer, graduated from 0° to 400°; specifications as under C9. Glass beads. Asbestos shield.

The apparatus assembly is shown in Fig. XV.

METHOD—The empty flask shall be tared, 250 g. of melted, well-shaken oil introduced, and a second weight taken. The flask shall be supported on an asbestos board with a slightly irregular opening of very nearly the largest diameter of the flask, and the apparatus assembled as in Fig. XV. The distillation shall be run at the rate of 1 drop per sec., and fractions collected in weighed flasks between the following temperatures: Up to 170°, 170° to 205°, 205° to 225°, 225° to 235°, 235° to 245°, 245° to 255°, 255° to 285°, 285° to 295°, 295° to 305°, 305° to 320°, and if feasible, 320° to 360°.

The character of the fractions and their weights shall be recorded.

PRECAUTIONS—Drafts on the distilling apparatus must be avoided.

NOTE—In noting the character of the fractions, the operator should observe the apparent amount of salts separating at room temperatures and roughly approximate the nature of the fraction, *e. g.*, solid, half solid, liquid, etc.

TEST H14—INDEX OF REFRACTION OF FRACTIONS

APPARATUS—Zeiss-Abbé refractometer.

METHOD—Water at 60° C. shall be circulated through the water jacket which surrounds the main

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[1] Adapted from *Forest Service Circular* **112**, U. S. Dept. Agriculture.

[2] A. H. T. 28220, E. & A. 3072.

prisms. After the temperature of the water in the jacket has been brought to this point, the prisms shall be separated and a few drops of the oil to be tested placed between them. They are then brought together and locked in position. The prisms shall now be rotated until the field of view consists of a light and dark portion. The telescope is provided with a recticule which can be brought into exact coincidence with the observed border line between the light and dark field. The compensator prisms are rotated until a sharp line of demarcation is produced. The index of refraction shall be read on the scale through the eye piece on the left side of the refractometer.

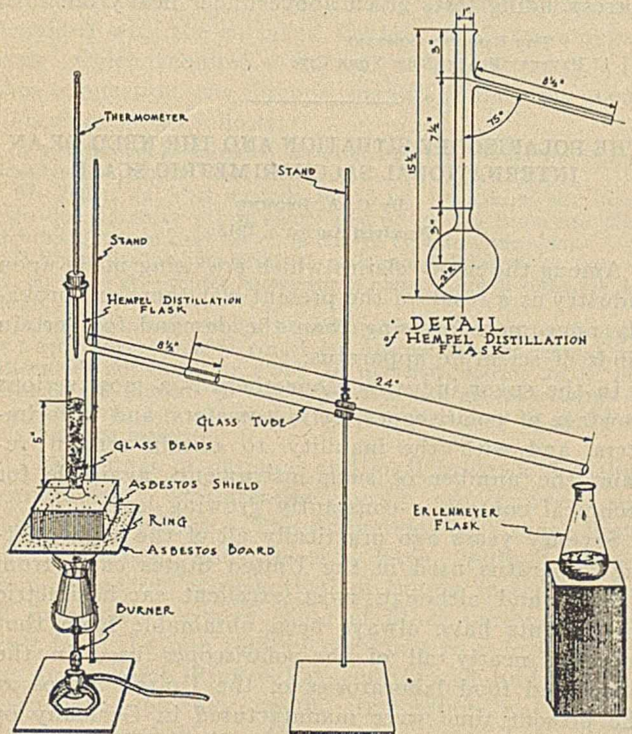

Fig. XV—Assembly of Hempel Distillation Test for Heavy Oil Forest Service Method

PRECAUTIONS—The temperature must be kept at 60° C. throughout the test. The lenses and prisms should be kept perfectly clean. Special lens paper should be used for this purpose so as to avoid scratching or damaging the surfaces.

Take care that the reflector does not show the line of a window sash which may be mistaken for the border line. Such a reflection can be detected by moving the mirror, when the true line does not move.

NOTES—The light is regulated by the reflector beneath the prisms until suitable illumination is obtained.

If the line cannot be produced, either there is insufficient oil between the prisms or the index of refraction of the material lies outside the range of the instrument.

With each refractometer is supplied a solid disc of known refractive index for use in checking the original adjustment of the instrument. Directions for its use accompany the instrument.

TEST H15—SULFONATION RESIDUE[1]

APPARATUS—Milk bottles, A. H. T. 33,964, E. & A. 4,450.

Centrifuge: Any milk bottle centrifuge will do; there are many types; refer to any apparatus catalog. A convenient type where only few tests are run is A. H. T. 33,936, E. & A. 1,883. Where many tests are being handled, A. H. T. 33,940, E. & A. 1,978 is better.

METHOD—Ten grams of the fraction of oil to be tested shall be weighed into a Babcock milk bottle. To this shall be added 40 cc. of 37 *N* sulfuric acid (total SO_3, 80.07 per cent), 10 cc. at a time. The bottle with its contents shall be shaken for 2 min. after each addition of 10 cc. of acid. After all the acid has been added the bottle shall be kept at a constant temperature of from 98° to 100° C. for one hour, during which time it shall be shaken vigorously every 10 min. At the end of an hour the bottle shall be removed, cooled, filled to the top of the graduation with ordinary sulfuric acid, and then whirled for 5 min. in a Babcock separator. The unsulfonated residue shall then be read off from the graduations. The graduated portion of the bottles measures 2 cc. and is divided into 10 major graduations. These major graduations are subdivided into either 5 or 10 smaller divisions. The reading, expressed in terms of major divisions, multiplied by 2, gives per cent directly.

PRECAUTIONS—The unsulfonated residue should be a clear transparent oil. If there is an apparent residue of dark or gummy appearance, the sulfonation is probably incomplete and the test should be repeated.

The addition of the acid should be regulated so that the mixture ceases to heat up on shaking, before another portion is added. If acid is added too quickly, foaming results.

Sometimes the material will start to foam on removal from the hot bath. Immersion in cold water will usually stop the foam. Proper strength of sulfuric acid is essential.

ACCURACY—0.1 per cent of amount taken, that is, 0.01 cc., unless the per cent residue exceeds 5, when 0.5 per cent variation is allowable.

NOTES—Occasionally a solid residue of white paraffin is obtained. In this case the bottle should be warmed sufficiently to melt the paraffin and re-whizzed. The reading may be taken while the material is liquid.

This method differs from the original Forest Service method in that the oil is weighed and not measured. On solid fractions an accurate measurement is impossible. Therefore, we have specified weight and our per cent result really represents cc. per 100 g. If a real per cent by volume is required the result should be multiplied by the determined specific gravity of the oil fraction and the result reported as per cent by volume (calculated).

The 37 *N* acid should contain 80.07 per cent total SO_3. It is made by mixing analyzed ordinary concentrated sulfuric acid with analyzed fuming sulfuric acid in the proper proportions. It is best to run a check test on the mixture to insure the fact that the strength is correct.

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[1] Adopted from *Forest Service Circular* **191**, U. S. Dept. Agriculture.

TEST H16—TAR BASES

This test shall be carried out exactly as described under H11, using 20 per cent sulfuric acid instead of 10 per cent caustic soda. As there are rarely more than 5 per cent of bases in any coal-tar oil, the tar-acid funnel, type 2, should be used for this purpose.

TEST H17—DRY SALTS AT 4.5° C. (40° F.)

APPARATUS—Copper beaker, 500 cc., A. H. T. 21,812, E. & A. 750. Buchner funnel (a suitable type is A. H. T. 28,616, E. & A. 3,254). Filter flask (a suitable type is A. H. T. 28,248, E. & A. 3,090). Letter press. Vacuum pump.

METHOD—The whole sample of oil after the extraction of tar acids as in H11 or H12 shall be used. (Note that this represents 100 cc. of the original oil.) It shall be placed in the copper beaker and cooled with stirring to 4.5° C. (40° F.) in a suitable bath and held at that temperature for 15 min. The contents of the beaker shall then be quickly filtered off on the Buchner funnel and the oil removed from the solids as quickly as possible. The solid cake shall then be removed from the filter and pressed *repeatedly* in a letter press between strips of blotting paper or filter paper until only a trace of oil is given up to the paper. The solids shall then be weighed. Their weight in grams divided by the specific gravity of the oil gives the per cent by weight of dry solids.

PRECAUTIONS—To quicken the filtering, a spatula should be used to press the solids down in the funnel and avoid channeling.

ACCURACY—± 1 per cent.

TEST H18—LIMPID POINT

APPARATUS—Test tube, 5 in. long by 1 in. inside diameter. Thermometer reading from 0° to 80° as used in D6. Distillation apparatus.

METHOD—Fifty cc. of dry oil shall be taken in a clean distilling apparatus such as used for naphthas and light oils and distilled to *dryness*, no thermometer being used. The condenser water shall be kept hot to avoid solidification of the distillate.

The distillate shall be well mixed and 30 cc. transferred to the test tube. This shall then be cooled, using a freezing mixture (3 parts of shaved ice to 1 part of salt) if necessary. During cooling the oil shall be kept agitated by stirring with the thermometer and cooling continued until a strong separation of crystals has taken place. The tube shall now be removed from the cold bath and warmed at the rate of 2° C. per minute, continually stirring, until all crystals disappear. The temperature registered by the thermometer at this moment shall be recorded as the limpid point.

PRECAUTIONS—If free water should be present in the oil, this might be mistaken for crystals, hence dry oil must be used.

ACCURACY—± 2° C.

NOTES—The best method to maintain the rise at 2° C. per min. is to place the tube in a beaker of water or brine 3° to 5° C. above the oil temperature and warm the bath, at about the 2° C. rate.

For oils with limpid points below 0° C. a special thermometer graduated from —30° to 50° C. may be used. The lowest temperature obtainable by the above freezing mixtures is about —20° C. If no crystals separate at this temperature a *very small* amount of powdered naphthalene may be added to seed out the solids. If no separation can be obtained in this manner, report should be made "no separation obtainable."

MIDDLE OIL TESTS

The usual tests made are water, specific gravity, distillation, tar acids, dry salts, tar bases, and limpid point, and these are made in the same manner as the corresponding tests given above under heavy oil.

THE BARRETT COMPANY
17 BATTERY PLACE, NEW YORK CITY

THE POLARISCOPE SITUATION AND THE NEED OF AN INTERNATIONAL SACCHARIMETRIC SCALE

By C. A. BROWNE

Received August 5, 1918

Among the many claims which are being made upon industry as a result of the present war there are probably none more pressing than the demand for certain kinds of scientific apparatus.

In the sugar industry alone there is a most serious shortage of polariscopes, refractometers, and colorimeters, and with the inability to obtain certain repairs the number of such instruments available for technical control is constantly growing less.

Seventy years ago practically all of the sugar testing apparatus used in the United States came from France, and although most excellent saccharimetric instruments have always been obtainable from that country, nearly all of the polariscopes used in the sugar and food laboratories of the United States at the present time were manufactured in Germany or Austro-Hungary. There are several explanations for this preference for instruments of German manufacture: (1) Since the time of Liebig the technical schools and universities of Germany have been most frequented by American students, the result being a greater familiarity on the part of scientists in this country with instruments of German origin. (2) At the time when many of our industries were established German emigrants were the most available for certain positions and German methods and apparatus were thus naturally introduced. (3) German manufacturers have been much more active than their French competitors in bringing their instruments to the attention of the American public.

With the entrance of the United States into the present war the importation of scientific apparatus from Germany and Austria came to an end. Those who needed polariscopes were thus obliged, as 70 years ago, to turn to France, the birthplace and original home of this instrument. The optical establishments of France were so taxed, however, with the manufacture of periscopes, field glasses, gun sights, etc., that no time could be spared for manufacturing other apparatus, although the instrument-makers of France expressed their willingness to supply the needs of foreign customers as soon as conditions permitted.

In a recent letter upon this subject, addressed to the writer, the head of one of the oldest establishments in Paris stated that he was most anxious to bring his polariscopes and other apparatus to the attention of the American public. He expressed himself as even willing to modify the types of his apparatus to satisfy individual preferences, but with one very important exception, *viz.*, that he should not be asked to copy or imitate German instruments. This exception happens, however, in the case of polariscopes, to be a very important one, for nearly all instruments used at present in the United States are provided with the so-called Ventzke or German sugar scale, which requires a normal weight of 26 g. In this connection the French manufacturer just mentioned writes as follows:

> Il y a de plus la question de la charge type 26 gr. qui parait adoptée aux Etats-Unis.
>
> M. Pellet, qui s'est servi de 26.048 gr., puis de 26 gr., aussi bien que de 16.29 gr., m'assure que 20 gr. est beaucoup plus commode et que c'est 20 gr. la charge type internationale.
>
> Il n'y a pas plus de difficulté pour moi à faire 26 gr. que 20 gr. ou 16.29 gr.—toutes basées sur le même pouvoir rotatoire du sucre.
>
> Je suis néanmoins obligé de dire que je n'aimerais pas faire 26 gr., car j'aurais l'air de copier les Allemands. Or ce sont les Allemands qui en réalité n'ont fait que nous copier, car les instruments à lumière blanche aussi bien que les instruments à lumière jaune ont été étudiés et construits pour la primière fois dans ma maison.

The feelings of national and local pride, which this manufacturer expresses so openly, are in every respect praiseworthy. The discoveries of Arago, Biot, Soleil, Laurent, and Duboscq have, without question, placed the contributions of France to the science of polarimetry above those of other nations. Subtract from the sum total of our knowledge in this field the part which France has contributed and the remainder is pitifully small. In certain particulars, however, English and German physicists have made important contributions and nothing is more certain than that the true scientist in the choice of his instruments will always be guided by expediency and not by prejudice or feeling. If the user of a polariscope desires his instrument to be equipped with a Jellet, or a Laurent, or a Lippich polarizing system, manufacturers should meet this wish irrespective of their own feelings of national or personal preference.

But apart from all this the question raised by the French manufacturer of substituting an international scale for the present German standard has at the present time a new and more far-reaching importance in view of the increasing consolidation of interests among the different allied nations. Leaving aside the fact that the Ventzke sugar scale is a German invention, there is much to be said in favor of the United States and all the other allied nations adopting a standard which was proposed as long ago as 1896 and which is known as the international sugar scale.

In 1896, at the Second International Congress of Applied Chemistry, Sidersky and Pellet advocated the adoption of a new international sugar scale, the normal weight of which should be 20 g. Among the advantages suggested for its adoption are the following: (1) The 20 g. scale being a compromise between the French 16.29 g. scale and the German 26 g. scale is free from all national bias. (2) The results obtained with the 20 g. normal weight are easily converted into percentages by multiplying by 5, while the results obtained by the French or German normal weights are not thus easily transformed. (3) Aliquot portions of 50, 25, 20, 10, and 5 cc. of the 100 cc. international scale normal solution represent even gram quantities (10, 5, 4, 2 and 1 g., respectively) which is not the case with the French or German standards. (4) The specific rotation of sucrose at a concentration of 20 g. in 100 cc. (18.62 per cent) is about the maximum, while it is perceptibly lower at concentrations above or below this amount. (5) A 20 g. normal weight is always available as a one-piece unit in the analytical set. The French and German normal weights are not always available as one-piece units and to make up the quantity from an analytical set of weights is inconvenient as well as open to error.

No immediate action was taken by the Second International Congress upon the proposition of Sidersky and Pellet, but the matter was again brought up at the third, fourth, and fifth meetings of this Congress, more especially by Dupont, who emphasized the statement made by Sidersky in 1896 "that without revolutionizing or disturbing the sugar industry the adoption of the proposed international scale would mark a decided step in advance. It would remove all the uncertainties which exist in saccharimetric standards as well as all the inconveniences and mistakes which result therefrom, since it would put in the hands of industrial and commercial sugar chemists analytical apparatus, whose graduation, being upon an identical basis, would furnish results that were everywhere alike."

While the various Congresses mentioned realized the numerous advantages of the proposed international sugar scale the influence of established usage was too strong to permit its displacing the national standards then in vogue. The representatives of the Teutonic nations were particularly opposed to the replacement of the German normal weight by the new international standard.

In 1912, at the seventh meeting of the International Congress in New York, Bates reported that investigations conducted at the U. S. Bureau of Standards showed the present German standard to be inaccurate inasmuch as 26 g. of pure sucrose would not polarize 100 upon saccharimeters provided with the Ventzke scale under the prescribed conditions of analysis. A committee was appointed to investigate the question and make a report in 1915, but the outbreak of the war put an end to all further proceedings.

In view of the uncertainty regarding the accuracy of the present German scale and in consideration of the numerous advantages of the proposed international scale, the present would seem to be a fitting time for the adoption of a saccharimetric normal weight of 20 g. by all the allied nations. The increasing shipment of sugar from the United States and

Cuba to England, France, and Italy makes a concerted action of this kind especially necessary just at present, and it is all the more desirable in view of the probability of an economic league in the near future between the various allied countries. If this could be done our sugar and food chemists would have at their disposal a convenient, rational, accurate standard, while our confrères in France, relieved from the embarrassment of having to copy a German scale, would be free to supply the demand for polariscopes, the increasing shortage of which is becoming at present a serious detriment in many industries.

An objection which has been urged against a change in the present sugar scale is that all polariscopes now in use would be rendered valueless. This objection, however, as Dupont pointed out at the Fifth International Congress of Applied Chemistry, is not a serious one. Polariscopes can be equipped with the new scales at little cost and without changing the optical construction of the instruments. If the adjustment of the new scale could be performed by our National Bureau of Standards the various polariscopes of the country would for the first time be placed upon a strictly uniform basis of comparison. Differences of as much as 0.3 have been noticed by the author between the 100° point of different German saccharimeters supplied to the American trade.

Preliminary to the adoption of the proposed international sugar scale a committee of scientists from the different allied countries should agree upon a constant for the angular rotation of a normal quartz control plate which shall read 100° upon a saccharimeter whose 100° point has been established by polarizing 20 g. of dry, chemically pure sucrose under the prescribed conditions of analysis. When this rotation value of the normal 100° quartz plate has been established for sodium, mercury, or other monochromatic light, instrument-makers and users of polariscopes will have an infallible means of verifying the accuracy of their scales.

If instrument-makers will then show a disposition to meet the wishes of their patrons in minor matters of construction there is no reason why the manufacturers of the allied nations cannot win for themselves a share of the market which heretofore has belonged almost exclusively to the Central Powers.

The manufacturers of the United States could find no better time than the present in which to make plans for the manufacture of polariscopes, saccharimeters, refractometers and other instruments that were formerly imported from Germany and Austria. Before entering this field, however, they should make it their aim to adopt only those standards and types which are most convenient in the opinion of the chemists who use them. Heretofore chemists have been obliged to take what the manufacturer was content to offer. It is time to reverse this illogical method of procedure. Let the chemists outline their specifications and give their orders to the manufacturer who is most ready to meet them. The writer is already in consultation with sugar chemists upon specifications for saccharimeters.

As it will probably be many years before commercial and scientific relations are resumed with the Central Powers, it would be the height of folly to wait for the resumption of such relations before restoring our depleted stocks of apparatus. It is time that we made ourselves independent of the Central Powers in this respect as in all others.

Uniformity of standards will make it much easier for one allied nation to supply the wants of another and will greatly help towards preserving that spirit of united action which a common enemy has brought about. The same intimate coöperation which exists between the Allies at the battle front will be necessary in the great work of reconstruction that is to follow. In the recent words of Mr. Lloyd-George, "Let us not make the mistake of dissolving the partnership the moment the fighting is over."

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ADDRESSES

THE POTASH SITUATION[1]

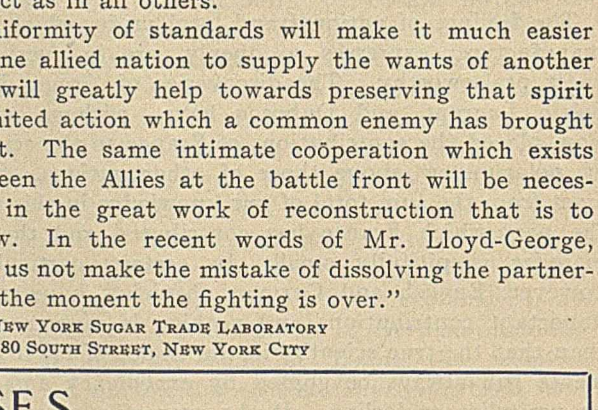
By A. W. Stockett

In the last year or two potash has been very prominently before the public, and so much information and misinformation has been published that it is very difficult to present any new facts on the subject. As over ninety per cent of all the potash used before the war was in the manufacture of fertilizer, the reading of this paper before the American Chemical Society may seem somewhat inappropriate.

Our dependence before the war on foreign sources for an important element in our food supply may be shown by the accompanying diagram.

The writer would be prepared to go even further than the above and for the present have our labor also dependent on a foreign source in the form of interned German prisoners of war.

The prospect of becoming independent of these foreign sources after the war is promising. When the nitrogen fixation plants now being erected by the Government are in full working order, there should be a sufficiency of nitrogen. The development of our pyrite supply and the establishment of sulfuric acid plants should insure a supply at reasonable prices. The potash supply is the only weak link in the fertilizer chain, and the writer is of the opinion that it is possible to develop a domestic potash industry.



It is well known to every one that before the war the entire world was dependent on Germany for its potash supply, and this country was importing annually about 1,000,000 tons of potash salts of various grades, containing approximately 240,000 tons of K_2O.

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[1] Paper delivered in the Symposium on Potash held by the Division of Industrial Chemists and Chemical Engineers at the 56th Meeting of the American Chemical Society, Cleveland, September 12, 1918.

The enactment of the "Potash Law" by Germany in 1910, which at one time threatened to become a serious diplomatic question, first drew attention to our entire dependence on Germany for a very important element of plant food, and in 1911 Congress made an appropriation for investigating our own sources of supply. It was not, however, until Germany put an embargo on the exportation of potash salts in January 1915, that the question became acute, and a serious attempt was made to develop our domestic sources.

The year 1915 may be said to have marked the beginning of the American potash industry, as in that year a little over 1,000 tons of K_2O were produced. This was increased to 9,720 tons in 1916, to over 32,000 tons in 1917, and it is probable that the production for the present year will reach 60,000 tons of K_2O.

At the present time over 60 per cent of the total is being obtained from natural brines, principally Searles Lake, California, and the lakes of Western Nebraska. The Desert Basin and Death Valley have long been names that appealed to the general public as probable locations of immense deposits of potash. These districts have been carefully examined by the U. S. Geological Survey, and as a result it may be stated that Searles Lake is the most promising individual source of potash at present known in this country. The extent of this has not been definitely determined, but it has been estimated to contain from 10,000,000 to nearly 20,000,000 tons of K_2O, which would be sufficient to meet the entire requirements of this country for from 20 to 40 years. Two companies are operating here and one of them, the American Trona Corporation, is said to be the largest individual producer of potash in this country. The eventual capacity of this plant may reach 75,000 to 100,000 tons of K_2O per year. The brine from the lake is treated by evaporation at Trona, on the edge of the lake, and it is intended to ship the crude salts thus obtained to the refinery at San Pedro on the coast. The brine is of a somewhat complex composition, and the successful treatment of it commercially was an interesting problem for our chemists. Borax and soda, and possibly salt as well, will be produced, and this should assist in enabling this plant to continue operations at a profit when the price of potash becomes normal. The geographical location of Searles Lake is very unfortunate, as more than 90 per cent of the pre-war supply of potash was used east of the Mississippi River. A low ocean freight rate *via* the Panama Canal would be an important factor in competing with foreign supplies.

The Nebraska lakes are at present supplying nearly half of the total amount of potash produced. These comprise a number of lakes, usually of small extent, located in the sand-hill region of the State. They usually consist of a shallow lake of brine, with a bottom of muck and hardpan, underlain by a sand impregnated with brine similar in composition to the lake waters. This is the principal source of the potash. It has not been found possible to make an estimate of the total potash content of these lakes, but it has been stated by the Director of the Nebraska Conservation and Soil Survey that with the plants now producing and building, the stores of high-testing brines would be greatly reduced within four years. One of the lakes that had been pumped dry has since filled up again, and it is claimed that there was no decrease in the grade of the brine. It may be, therefore, that the life of these lakes will be considerably prolonged and this is very much to be desired, as this source of potash has so far been the foundation of the domestic supply. The district is handicapped by its geographical location, entailing high freight rates to the points of demand. It is probable that eventually a central refining plant will be erected, and by producing a very high-grade product, freight rates per unit of K_2O could be reduced by one-half.

The giant kelps of the Pacific Coast ranked second as a source of supply in 1917, having produced 11 per cent of the total for that year. As this source is being described by Mr. Turrentine it will not be further dealt with here, except to point out that it would be almost impossible to locate a source that is further from the principal centers of demand, as the Pacific Coastal states, including Hawaii, use less than 2 per cent of the normal supply of potash.

A little over 2,400 tons of K_2O were produced from the alunite deposits near Marysvale, Utah. This was mostly in the form of a high-grade sulfate 97 per cent pure. The alunite is crushed to about $^1/_2$ in. mesh, and roasted in a rotary kiln, using pulverized coal as fuel. The calcined material is leached with hot water in a closed tank at a temperature equivalent to 60 lbs. steam pressure, which takes the potassium sulfate into solution. The solution is filtered in a Kelly filter press, and the clear filtrate is then evaporated in Swenson triple-effect evaporators, and the resulting crystals centrifuged and sacked for shipment. No estimate of the cost of production is available, but unless it is possible to utilize the alumina in the residue, which is not being done at present, it does not seem that potash can be produced from this source at a profit at normal prices. In *Bulletin* 451, published by the Bureau of Soils, entitled "The Recovery of Potash from Alunite," by Messrs. Waggaman and Cullen, the possibilities of obtaining both alumina and sulfuric acid, as well as potash, is discussed, and it was estimated that this should be very profitable at present prices, and possibly at normal prices also. Calcined alunite, containing 15 per cent of K_2O, has also been marketed in small quantities for use in fertilizers, as it has been found by experiment that this is as effective per unit of K_2O as the soluble sulfate and chloride salts. If a deposit of alunite could be discovered in the East near the centers of demand for fertilizers, it is probable that this calcined product could be produced at a profit at normal prices, but with the location of the present known deposits, the high freight rate per unit of K_2O will be prohibitive.

In the opinion of the writer, the dust from the cement kilns is probably the most promising source of a permanent domestic potash supply. As the result of a careful investigation by the Bureau of Soils, it has been estimated that the maximum amount of potash that might be recovered from all the cement works in the country would be 100,000 tons of K_2O.

It is not probable that this figure will ever be reached, as some plants do not have sufficient potash in the raw mix to make its recovery profitable, and others for various reasons would not find it advisable to install plants. It does not, however, seem unreasonable to expect that the amount from this source should reach 50,000 tons of K_2O per year, which is 20 per cent of our normal requirements. The geographical position of the cement industry is exceptionally fortunate, as approximately 70 per cent of the total amount of cement manufactured is produced east of the Mississippi, and this region consumes approximately 90 per cent of the normal supply of potash. The first cement plant to recover potash from this kiln dust was the Riverside Portland Cement Company, of California. Owing to litigation with the fruit growers in the vicinity, who claimed that the fine dust escaping from the kilns was causing damage to the fruit trees, the company was compelled to take steps to abate the dust nuisance. A Cottrell electrical precipitation plant was installed, and when the dust thus collected was analyzed, it was found to contain about 10 per cent of K_2O, so that at present prices of potash this is a very profitable part of the plant. The installation was completed early in 1913, and has been in continuous and successful operation ever since, so that there is no longer any question about the practicability of this method. By the end of this year there will be about a dozen cement plants recovering potash from the kiln dust, with a probable production of 10,000 to 12,000 tons of K_2O per year. The recovery of the maximum amount of potash and its concentration from the flue dust involved some very interesting chemical problems, which appear to have been successfully solved. Published figures show that potash can be produced profitably from this source for 50 cents per unit of K_2O, which should insure the permanence of this source of supply under any conditions.

Another source which has even greater possibilities than the cement plants, although up to the present but very little has been done, is the dust from the blast furnaces manufacturing pig iron. Mr. R. J. Wysor made some investigations and experiments at the plant of the Bethlehem Steel Company, and it was found that with the Cottrell electric precipitation, practically all the dust and fume entering the treater could be precipitated successfully. In many cases the iron ore used in manufacturing the pig iron contains sufficient potash to make its recovery profitable, with the additional great advantage of cleaner-gas for use in the stoves and boilers. The amount of potash available from this source has not been definitely estimated, but it is probable that it would be from 200,000 to 300,000 tons of K_2O per year.

As far as the writer has been able to learn, there is at present only one plant being installed at any of the blast furnaces for the recovery of potash. All of the manufacturers are at present so intent on producing the maximum amount of pig iron that there is very little possibility of getting them to realize the importance of developing a domestic potash industry.

Another source which promises a small but permanent supply is the waste from distilleries where molasses is used to produce alcohol. This source ranked third in 1917, with a production of 2,800 tons of K_2O. Recent improvements in methods are claimed to have reduced costs and increased the potash extraction, and as this is practically a by-product it is probable that potash can be produced at a profit after the war.

There are some thirty or forty small producers of potash from wood ashes, mostly in Michigan and Wisconsin, but the total amount from this source is only about 400 tons of K_2O per year, and it is not probable that they will be able to continue operations under normal prices.

The greatest potential sources of potash are the potash-rich silicate rocks, and of these the most promising are the greensands or glauconite of New Jersey, the Cartersville slates of Georgia, and the leucite rocks of Wyoming. Any one of these sources would be capable of supplying our entire requirements for many centuries. Many patents have been issued in the last fifty years for methods of extracting potash from these silicates, but no general commercial process has yet been developed. Several companies have been experimenting on the greensands on what may be called a commercial demonstration scale, and claim that under normal conditions they will be able to produce potash at less than $1 per unit of K_2O.

Another company is operating on a small scale on the Cartersville slates, and producing a material containing 4 per cent of water-soluble K_2O, which is being used locally as a fertilizer. Experiments have also been carried out on the leucite rocks, which give promise of being successful.

There are several million tons of tailings from the gold mines in the Cripple Creek district of Colorado, averaging about 10 per cent of K_2O. These are already finely ground and are close to transportation and supplies. Experiments have also been made with these, but so far without success.

The development of a commercially successful process of treating the silicate rocks would solve the potash question permanently, and this problem should not be beyond the skill of our chemists and metallurgists.

In conclusion, the writer is of the opinion that the sources of potash already discovered are sufficient to supply the requirements of this country, if sufficiently developed. He also thinks the prospects of this development are favorable, but it will probably require some kind of assistance by the Government. This might perhaps best be done by subsidizing the domestic industry to a suitable degree. In this way, the cost to the Government would be moderate and the expense would be distributed, and it would thus be possible to break the German monopoly without placing a hardship on any particular class.

U. S. Bureau of Mines
Washington, D. C.

RUSSIA'S PRODUCTION OF PLATINUM[1]

By Albert R. Merz

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Russia became the chief center of the production of platinum soon after its identification as a product of the Urals in 1823. Exploitation began in 1824. Previous to this time Colombia, then having an annual production of approximately 16,000 ounces, had been the only purveyor of platinum to the world's market. For a few years the production of Russian platinum was in quite small quantities and obtained as a by-product in the washing of gold-bearing sands, but as acquaintance with its value grew and sale was found for it, the output gradually increased.

In 1827 the Russian Minister of Finance, Count Egor Frantsovich Kankrin, wishing to increase the yield of platinum and to furnish the government with an important source of income, proposed the coinage of platinum. This was approved by the Czar and coinage was instituted in 1828. Simultaneously with the introduction of platinum money the government prohibited the export of platinum abroad and also imposed a tax of 10 to 15 per cent on its production. This tax which was in kind was not, however, burdensome to the Russian platinum producers for they used the labor of serfs in working the mines and in consequence the cost of securing the platinum was very little. The price paid by the government to the producers was fixed at $4.21 an ounce.[2]

The first year after the realization of the measure providing for the coinage of platinum the output rose to over 50,000 ounces and in 1843 it reached 112,571 ounces. In 1845 the coinage of platinum money and the purchase of the metal by the treasury were discontinued and the restrictions on its use for other purposes were removed.

In all, for the 18 years (1828–1845) there were coined 453,014 ounces of platinum. After the discontinuance of coinage in 1845 the government began gradually to withdraw from circulation the money which had been issued and secured about 80 per cent of it. The Russian platinum industry left thus upon its own resources was for a time benumbed and the annual production dropped to less than 1,000 ounces.

With the end of the fifties the production of platinum began to develop anew and in 1862 the output reached 75,060 ounces. In 1859 the mint had accumulated a stock of platinum amounting to 472,706 ounces, of which 234,412 ounces was in coin. Sales of the metal had been made in small quantities to the Parisian manufacturer, Quennesen, and to others, but in 1862 the entire quantity remaining in the treasury was sold to the London firm of Johnson, Matthey & Co., refiners to the Bank of England, after which the tax in kind was revoked. The consumption of platinum meanwhile continued to grow with each year and parallel with this increasing consumption the quantity of platinum secured in the Urals also increased so that in the closing years of the 19th century it attained to 130,000 to 190,000 ounces annually, approximately 90 per cent of the world's total annual output. Simultaneously with this growth in production there arose among the big foreign platinum dealers a desire to seize control of the platinum industry, and companies were formed abroad who monopolized the Russian industry and fixed according to their own whim the price of the metal. The price from this time on began to be subject to violent fluctuations though the average gradually increased. The complete

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[1] Prepared as a part of the work on platinum in the course in chemical economics and statistics at George Washington University.

[2] On the basis of 1 ruble equivalent to 77 cents. The value of the Russian ruble was changed from 77 to 51 cents by a law promulgated on September 10/August 29 of the year 1897.

lack of stability in price and the uncertainty of sale placed the independent Russian producers in a most irksome position and deprived them of the possibility of making expenditures for explorations and for the development of technical improvements in the working of their deposits. As a result, the production of platinum by the independent and smaller producers has been greatly reduced. The yield of platinum since the beginning of the present century has consequently had a downward tendency.

The platinum beds of Russia which have a commercial importance are not only all located in the Ural Mountains, but they are concentrated in a very limited territory. These beds are alluvial in character and consist of placers formed from the destruction of the mother-rock containing the platinum. These placers are likewise auriferous and are associated with certain olivine rocks called dunite.

At the time of the outbreak of the war in 1914 the greatest proportions of the platinum output in the Urals were secured in the Nizhne Tagil and Isov districts. The beds of the first district are found, for the most part, on the west slope of the Urals, while those of the second are distributed along its eastern slope and can in turn be divided into two districts, the Goroblagodat and the Bisersk. Besides these there has been in comparatively recent years a development of production in the northern Urals in the Nikolae-Pavdinsk and the Rastes districts, and also in the mines of the Sysertsk mining district.

In the Isov district the production of platinum is concentrated in the rivers and channels composing the system of the River Is. To the north of this region, towards the borders of the Rastes and Nikolae-Pavdinsk districts, platinum is furnished by the Sosnovki, Kytlymi, and Mala Kos'va Rivers. Platinum is obtained together with gold still farther to the north on the left tributary of the Vagran and on the system comprising the rivers Lobva, Nias'ma, Lialia, Aktai, Emekh, Talits, and others; here the platinum is met with in subordinate quantities with gold and it is similarly obtained on the Mala Kos'va; more to the east of the above-designated districts it is secured in the placers of the Ivdevl River.

To the south of the Isov area in the region of the Baranchinsk, Verkhne-Turin, and Nizhne-Turin works, platinum mines are worked on the tributaries of the Tagil River and on the Imiann and Tura Rivers, as well as on the tributaries of the Salda River.

In the boundaries of the Nizhne-Tagil district the richest placers are found in the valleys of the Visim, Mart'ian, Sisim, Chaush, Cherna Rivers, and others. Farther to the south there is observed a disappearance of the reliable platinum beds and they are met with after that, together with gold, in the placers of the Nev'ian, Verkhne-Iset, Bilimbaev, Alapaev, Sysert, Kyshtym, and Mias areas and also on the Tanalyk, Sakmar, and Urtazym Rivers. In many placers of the southern Urals platinum is replaced by other metals of the platinum group, principally osmiridium.

The placer deposits of platinum cannot be distinguished in any way by their manner of occurrence from those of gold and, besides, in many cases the placers contain both precious metals simultaneously. As a consequence of their mode of occurrence the platinum placer mines are worked by methods differing but little from those employed in the exploitation of the gold placers.

As has already been indicated, the world's requirements for platinum have been almost entirely supplied by Russia from early times, and in 1914 that country furnished all but 7 per cent of the world's production for the year. In Table I there is given the annual production of platinum in Russia from the first year of the exploitation of the platinum (1824) to the year 1915:

TABLE I—PRODUCTION OF CRUDE PLATINUM IN RUSSIA

Year	Troy ounces	
1824	1,066	
1825	6,116	7,182
1826	7,120	
1827	13,571	
1828	50,111	
1929	41,457	
1830	56,088	168,347
1831	56,891	
1832	61,394	
1833	61,749	
1834	54,561	
1835	55,509	290,104
1836	61,973	
1837	62,520	
1838	64,291	
1839(*a*)	49,500	
1840	49,360	287,644
1841	57,398	
1842	64,106	
1843	112,571	
1844	52,128	
1845	24,878	311,081
1846	619	
1847	632	
1848	1,053	
1849	4,964	
1850	5,079	12,347
1851	6,135	
1852	8,677	
1853	32,402	
1854	355	
1855	513	48,082
1856	757	
1857	4,065	
1858	5,444	
1859	29,413	
1860	32,380	72,059
1861	55,454	
1862	75,060	
1863	16,084	
1864	12,770	
1865	73,123	232,491
1866	56,129	
1867	57,399	
1868	64,560	
1869	75,310	
1870	62,649	316,047
1871	65,918	
1872	48,974	
1873	50,688	
1874	64,770	
1875	49,603	279,953
1876	50,670	
1877	55,504	
1878	66,529	
1879	72,809	
1880	94,744	340,256
1881	95,982	
1882	131,293	
1883	113,666	
1884	71,952	
1885	83,316	496,209
1886	138,785	
1887	141,721	
1888	87,361	
1889	84,746	
1890	91,461	544,074
1891	136,204	
1892	147,032	
1893	163,963	
1894	167,481	
1895	141,936	756,616
1896	158,522	
1897	180,105	
1898	193,452	
1899	191,701	
1900	163,624	887,404
1901	204,850	
1902	197,267	
1903	193,225	
1904	161,270	
1905	168,416	925,028
1906	185,756	
1907	173,587	
1908	157,787	
1909	164,594	
1910	176,331	858,055
1911	185,617	
1912	177,467	
1913	157,731	
1914	157,178	
1915	119,789	797,782
		7,630,761

(*a*) Estimated. The actual production for the first half of 1839, according to the *Annuaire du Journal des Mines de Russie*, was 26,047 oz. Neumann gives 1,505 kg., equivalent to 48,387 oz., as the entire production of platinum in Russia in 1839, but the writer has been unable to find his authority for this figure.

The figures for this table were obtained from official statistics of the Russian government with the exception of the value for the year 1915, which was secured from "Mineral Industry," and this value is stated to have been taken in its turn from official figures.

The total yield of crude platinum according to these values from 1824 to 1915, inclusive, amounted to 7,630,761 Troy ounces. This aggregate yield, however, should really be increased to approximately 9,500,000 ounces, for the official data fail to give the total production at the mines because a portion of the actual output was stolen by the miners and another portion was concealed by the producers to avoid the payment of tax upon it. Estimates of the amount thus not officially accounted for vary considerably and by some it has been placed as high as 60 per cent of the production officially announced. The value usually quoted is 25 per cent.

The values for production given in Table I are shown graphically in Fig. 1.

The most salient characteristics of this curve together with their probable causes may be mentioned. First, there is to be noted a sudden rise of the production curve in 1828, the year in which coinage was commended. The curve continues high until 1843, when it reaches a pronounced peak which is accentuated by the sudden drop through the years 1844 and 1845 to the minimum of 1846. In 1843 the question arose whether the coinage of platinum should be suspended. Before making a definite decision on this question it was determined to continue the coinage of platinum two years, but only in such quantity as to take the output obtained by the platinum producers up

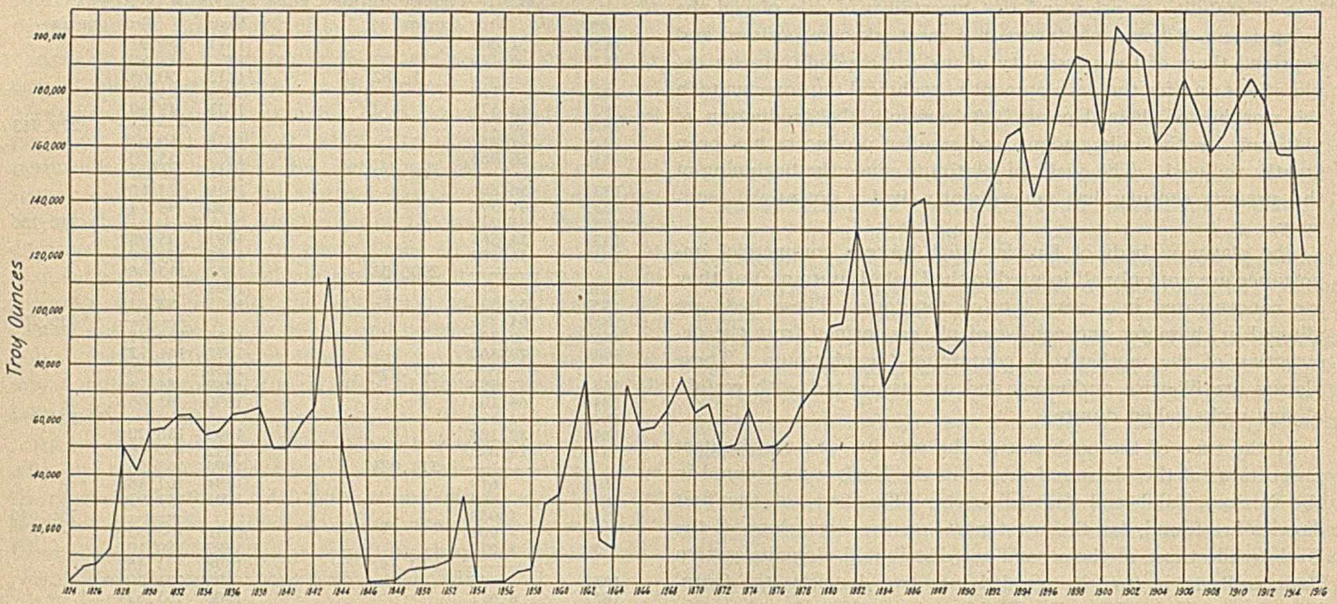


FIG. 1—PRODUCTION OF CRUDE PLATINUM IN RUSSIA, 1824–1915

to April 1, 1844. The producers were also informed that the platinum obtained after that date could not be accepted by the government. In 1845 complete suspension of the coinage of platinum was brought about by an imperial ukase of date June 22. The platinum industry now fell into such a state of decline that whereas there had been an annual production of 50,000 ounces or more the yield of the metal was reduced to that obtained as a by-product of gold mining.

The slow rise in production from the minimum for 1846 was again brought to an abrupt end in 1853 with the commencement of the Crimean War. During the years of this struggle which continued till 1856, the annual production became less than at any period in the history of the Russian industry. The extent to which the platinum industry had become dependent upon French and English purchasers is very forcibly brought to view. Other mining industries of Russia not thus dependent failed to show any such decrease in production for these years. Thus the yields of gold, silver, and copper for the years 1852 to 1857 were as follows:

YEAR	Gold Ounces	Silver Ounces	Copper Short tons
1852	719,796	559,892	7,413
1853	770,828	539,130	7,143
1854	840,886	555,495	7,056
1855	868,627	549,281	6,836
1856	871,853	545,818	6,848
1857	912,984	557,273	6,102

The year 1859 marks the commencement of a rapid rise in the production of platinum. Two causes apparently had an influence in bringing about this upward turn. First, there was an increased demand for the metal due to the introduction of Deville and Debray's process in the manufacture of platinum vessels and other ware which considerably lowered the cost of production of such manufactured ware. Second, there was the effect of the appointment of a commission by the Crown in 1859 for the purpose of considering the advisability of again coining platinum. This commission in 1862 recommended that coinage be again instituted. It is to be noted that the emancipation of the serfs, which in 1862 had a very depressing influence upon practically all the mining industries of Russia, had apparently no effect upon the production of platinum.

The chasm-like gap in the curve which appears for the years 1863 and 1864 seems to have had a number of causes. The intention to again coin platinum was definitely abandoned in 1863. There was also a lessened demand for platinum in foreign countries brought about by poor trade conditions and war, and an accumulation of unsold and unpurified metal in the hands of the producers.

The minima for the years 1866 and 1875 were probably the consequences of the financial panics in England during those two years.

In 1877 Johnson, Matthey & Co., who had up to this time controlled the greater part of the platinum trade, increased the price which they had been paying for the crude metal and the effect of this advance in price is seen in another upward shoot of the curve. Demands on the supply of platinum for use in the manufacture of incandescent lights and for other electrical appliances now began to have a marked influence on the platinum market.

The decreased production for the years 1883 to 1885 was the result of the exhaustion of some rich deposits of the metal by intensified working in 1882.

The diminished production for the years 1888 to 1890 has been attributed to the drafting of employees in the Urals by the Russian government for the building of the Trans-Siberian Railway. This is claimed to have depleted the mines of laborers and made it difficult to keep up the usual output. Unfortunately the writer has been unable to secure official figures of the number of workers engaged during the years 1885 to 1887 in producing platinum for comparison with the number of those similarly engaged during the years in question. A comparison of the number of persons employed in the recovery of platinum during the years 1882 to 1884 with the number thus engaged for the years 1888 to 1890 does not tend to confirm this claim. The numbers of employees for the years compared are as follows:

YEAR	Workers	YEAR	Workers
1882	2,196	1888	4,959
1883	2,074	1889	5,461
1884	1,768	1890	5,853

Officially the decrease in output for these years was assigned to a diminution in the number of active mines in the Goroblagodat mining district where there were but 69 mines in 1888 against 85 in 1887. The quantity of sand washed was smaller in consequence and the content of platinum in the sand had also decreased. The main cause of the fall in output appears to have been the diminution in richness of the platinum sands washed for the first two years and of the quantity of sands washed for 1890.

It is stated that in 1895 long-continued rains did not permit washing through the whole season and production was therefore reduced. Certainly a lower content of platinum in the sands washed contributed to the decrease in the yield.

The year 1898 was an important one for the Russian platinum industry, as it was marked by the establishment of the "Société Anonyme d'Industrie du Platine" in Paris, which began to purchase mines, to lease others, and to enter into long-term contracts with the proprietors of the largest placers, whose mines it was unable to buy for the purchase of their entire output. It thus gradually secured control of the greater part of the platinum industry. The production of platinum as well as the refining of the metal now fell almost entirely into the control of foreigners.

Floods in 1900 are said to have caused the decrease in output for that year. The following year is distinguished by the maximum yield for any year of the industry in Russia.

The richness of the platinum deposits continued to decrease and in order to secure a given quantity of platinum, greater quantities of the lower grade sands had to be washed. In the early years of the 20th century dredges were introduced in the valley of the River Is, where the most productive placer deposits occurred. There were, however, but few of these used and hand washing continued to be the main method of working the sands. In 1909, it is said, four dredges delivered about 13 per cent of the total production and the next year about 20 per cent of the entire output was recovered by dredges or other mechanical excavators. In 1914 about one-third of the platinum produced was secured by modern methods of working.

The Russo-Japanese war in 1904–1905 is claimed by a number of writers to have caused a curtailment of production on account of the drafting of many of the Ural miners. Also the internal disturbances which arose in Russia immediately afterwards are claimed to have had a like influence. A study of the official figures relating to the period in question does not bear out such statements. The chief factor influencing the variations in annual output from the commencement of the 20th century through 1906 seems to be the content of platinum in the sands washed. Thus, in spite of the two causes above claimed as responsible for the drop in 1904–1905, the number of mines, the number of miners employed in producing platinum alone, and the number of tons of sands washed, all had upward tendencies.

In Table II are contained statistics of the number of deposits worked, the number of miners employed, the number of tons of sand washed, and the yield of platinum per ton of sand, so far as they could be obtained.

TABLE II—STATISTICS OF THE PLATINUM INDUSTRY OF RUSSIA

YEAR	Mines	Miners	Sand Washed Tons	Wt. of Platinum Grains per Ton
1864	...	...	16,445	...
1865	...	...	112,530	...
1881	66	...	271,514	...
1882	82	2,196	363,437	208
1883	107	2,074	276,164	...
1884	71	1,768	352,138	...
1885	58	...	313,974	...
1886	83	...	415,951	...
1887	93	...	1,115,409	...
1888	75	4,959	1,062,746	39
1889	72	5,461	1,213,122	33
1890	82	5,853	854,688	51
1891	102	6,120	1,417,805	46
1892	87	8,061	1,588,665	44
1893	97	7,234	1,723,084	45
1894	97	5,546	1,833,675	43
1895	77	5,628	1,729,247	39
1896	73	6,981	1,904,032	40
1897	77	8,050	2,235,701	39
1898	82	8,034	2,671,242	34
1899	78	9,197	3,148,221	29
1900	100	1,763	749,657	...
1901	120	2,025	776,712	...
1902	122	1,803	644,942	...
1903	110	2,699	1,084,186	...
1904	133	3,066	1,298,724	...
1905	141	3,498	1,805,462	...
1906	157	3,292	1,827,684	...
1907	157	787	238,682	...
1908	158	555	345,914	...
1909	154	864	289,776	...
1910	189	1,587	999,176	...

From 1906 on the number of miners and the quantity of sand washed is given for only those mines where platinum alone is produced.

As has been previously stated, the refining of platinum has been almost entirely in foreign hands and consequently the crude platinum with the exception of a very small quantity has been exported from Russia to be refined in other countries. The small amount refined in Russia was that required for local consumption. The largest platinum refining works was formerly that of Johnson, Matthey & Co., in London, but Heraeus & Co., of Hanau, Germany, early in the eighties, took the lead from that company and maintained it into the 20th century. Since the establishment of the Société Anonyme d'Industrie du Platine, its platinum refinery in Paris has refined most of the crude platinum produced in Russia. As a result of foreign control, the prices of crude platinum were subject to much speculation which had a very unfavorable reaction upon the condition of the Russian platinum industry. In view of this a law proposed by the Ministry of Trade and Industry was enacted, of date Dec. 20, 1913, which placed a prohibition on the exportation of crude platinum and provided for the establishment of a refinery in Russia. All the platinum in the country was subject to strict registration which made impossible the secret sale of the metal to foreign buyers. As a result of this, the position of many platinum producers became extremely embarrassing since they were unable to realize on their stocks of platinum in view of the limited consumption of the metal within the country. The State Bank in order to relieve the distress of these producers issued loans to them on the platinum that they held.

The prohibition of export was found to be in conflict with certain international treaties and it was then determined to place an export tax of 30 per cent *ad valorem* on platinum from July 1915, the price of the crude metal to be fixed by the Council of Ministers.

TABLE III—EXPORTS OF PLATINUM FROM RUSSIA TO

YEAR	Great Britain	France	Germany	Austria-Hungary	Total
1861	...	...	...	..	30,546
1862	...	...	...	..	25,806
1863	5,266	1,198	...	..	6,464
1864	20,539	...	9,840	..	30,019
1865	...	...	6,596	..	6,596
1866	...	2,357	20,025	..	22,383
1867	...	...	22,304	..	22,304
1871	31,941	...	33,310	..	65,251
1872	99,299	...	36,905	..	136,204
1873	76,891	...	10,533	..	87,424
1874	76,364	...	17,379	1,053	94,796
1875	131,135	...	23,699	..	154,834
1876	21,066	...	13,693	..	34,759
1878	24,752	...	18,433	..	43,185
1880	24,752	...	...	..	24,752
1881	...	...	...	..	31,072
1882	...	...	...	..	48,978
1883	30,545	...	27,386	..	57,931
1884	14,746	...	54,245	..	68,991
1885	14,746	...	137,455	527	152,728
1886	27,386	...	124,815	..	152,201
1887	26,332	...	138,509	..	164,841
1888	26,859	...	93,743	..	120,602
1889	20,539	...	113,756	..	134,295
1890	6,846	...	102,170	..	109,016
1891	...	...	99,536	..	99,536
1892	...	527	116,916	..	117,443
1893	...	...	71,097	..	71,097
1894	...	...	57,404	..	57,404
1895	122,709	...	26,859	..	149,568
1896	122,182	...	28,966	..	151,148
1897	66,358	527	86,370	..	153,255
1898	93,217	1,053	50,032	..	144,302
1899	9,480	1,053	99,536	..	110,069
1900	23,699	11,060	12,640	..	47,399
1901	61,618	7,373	2,633	..	71,624
1902	38,972	527	1,053	..	40,552
1903	10,533	28,439	22,119	527	61,618
1904	23,699	31,599	36,865	..	92,163
1905	18,433	9,480	33,705	..	61,618
1906	28,966	125,869	48,978	..	203,813
1907	32,126	110,069	14,746	..	156,941
1908	12,639	99,537	63,197	527	175,900
1909	10,006	127,449	122,182	..	259,637
1910	22,119	135,875	101,116	(Sweden) 13,693	272,803
1911	1,053	168,527	51,612	..	221,192
1912	2,107	169,580	50,558	..	222,245
1913	1,580	140,615	58,458	..	200,653
1914	...	64,778	17,906	..	82,684
1915	66,884	7,900	...	United States 5,266	80,050

In Table III is given the quantity of platinum exported from Russia and the countries to which it was sent for those years for which statistics were obtainable.

A study of this table yields some interesting and even surprising information in view of the fact that the literature is everywhere permeated with statements indicating that first Johnson, Matthey & Co. and then the French "Compagnie Industrielle du Platine" monopolized the refining of Russian platinum and were absolute masters of the market. A summation of the exports of platinum from Russia to France, England, and Germany for the years 1863 to 1915 (data for 7 years missing) shows that France received 1,245,392 ounces, England 1,448,384 ounces, and Germany 2,279,280 ounces. The total exports for four of the seven years for which detailed information is lacking are less than 150,000 ounces and those for the remaining three years are certainly not more than 250,000 ounces. Therefore, and since Germany undoubtedly secured a large share of this platinum also, the above sums would not be vitally affected by the missing data. We find, then, that the Germans actually received more platinum than the French and English monopolists.

Dividing the period 1863–1915 into five subperiods, we have the exports for each of these given below:

YEARS	France Ounces	England Ounces	Germany Ounces
1863–1880	3,555	512,005	212,717
1881–1890	0	167,999	792,079
1891–1900	14,220	437,645	649,356
1901–1910	676,217	259,111	446,594
1911–1915	551,400	71,624	178,534
	1,245,392	1,448,384	2,279,280

It is seen from these figures that Germany received more platinum from Russia than England did during each of these periods, except the first, and though its importations for the last two periods were exceeded by those of France that it nevertheless secured over 28 per cent of the total exports even then.

As already stated, the literature contains numerous references to the "monopolies" of the English and of the French and it is interesting to note in this connection that even the official Russian publication prepared for the World's Columbian Exposition at Chicago has, in an apparent endeavor to foster this impression, reversed the exports to England and Germany for the years 1885 to 1890 in its table of exports for the years 1884 to 1890.

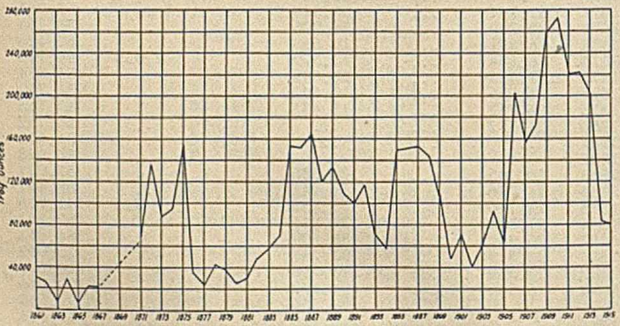


FIG. 2—EXPORTS OF PLATINUM FROM RUSSIA, 1861–1915

The annual exports of Russia are shown graphically in Fig. 2. It is to be noted that the curve is subject to quite pronounced fluctuations and therefore it is necessary to take a more or less long period of time for the determination of the relation of export to production of platinum.

Taking the period from 1882 to 1914 for this purpose, we find that the quantity of platinum exported amounted to 83.4 per cent of the production. It must be considered also that official statistics on the export of platinum abroad for the period in question gave figures considerably lower than the actual export as part of the platinum was sent abroad by mail and baggage and thus escaped registration.

Making a more detailed study of the production of platinum in the Urals, we find that the output for the 5 years 1910–1914 was divided as follows:

DISTRICT	1910	1911	1912	1913	1914
South Verkhotur.......	111,070	121,314	118,048	102,552	106,528
Perm.................	46,068	46,885	38,709	36,878	38,050
North Verkhotur.......	11,862	11,362	13,166	11,376	7,426
Cherdyn..............	6,359	5,016	6,162	6,109	4,753
South Ekaterinburg....	972	1,040	1,382	816	421
	176,331	185,617	177,467	157,731	157,178

We see from an inspection of the above table that for the year 1914 the South Verkhotur district produced 67.8 per cent of the total production, the Perm district 24.2 per cent, the North Verkhotur 4.7 per cent, and the remaining 3.3 per cent were obtained in the Cherdyn and the South Ekaterinburg districts.

In the South Verkhotur and Perm districts there are great enterprises which use dredges in working the platinum placers. These are able to work the placers with a low content of platinum. The working of the majority of the small and medium-sized mines, however, is carried on by very primitive means, especially by the help of "starateli" or tributers.

The Iuzhno (South)-Verkhotur district takes first place in the production of platinum. The greatest quantity of platinum is obtained here on the Nizhne-Turin, Verkhne-Turin, Kushvin, Baranchin, and Znamen areas of the crown lands where in 1913 there were 136 mines yielding 55,772 ounces of platinum. Next comes the areas of the Nizhne-Tagil possessional district belonging to the heirs of P. P. Demidov, where 6 mines gave a yield of 42,409 ounces. Finally, on the lands of the peasant proprietors, 89 mines in the Visimo-Shaitan, Cherno-Istochin, Nizhne-Turin, and Verkhne-Turin areas furnished 4,371 ounces.

The decrease of yield in this district in 1913, in comparison with 1912, is explained by (*a*) a curtailment of the production of the Demidov mines by about 3,500 ounces in conjunction with the unfavorable condition of the platinum market, (*b*) a decrease in yield of the mines situated on the peasant owner lands by approximately 500 ounces, and (*c*) a fall in production of the mines of the crown lands, chiefly those of the Société Anonyme d'Industries du Platine, by about 11,500 ounces.

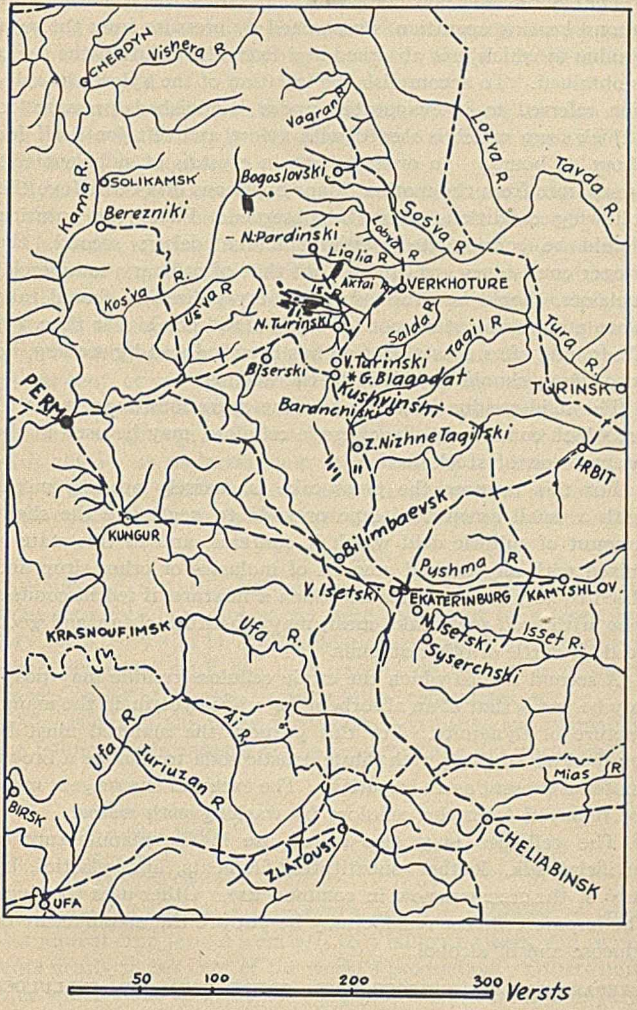
About one-third of the platinum produced in the district is secured by dredging while the remainder is obtained by hand labor, partly by the work of starateli.

In 1914 the yield of platinum in this district again rose and reached 106,528 ounces, which is explained by an increase in the number and the production of the mines on the peasant lands. The number of mines increased from 89 to 134 and their output from 4,371 ounces to 15,786 ounces. In spite of an increase in the number of mines on the crown lands their production decreased by 7,557 ounces. Altogether there were 296 mines worked in this district in 1914, 65 more than in 1913.

The Perm district takes second place in respect to the quantity of platinum produced. The precious metal is obtained here in the Krestovozdvizhen ("Erection of the Cross") mines belonging to the company "Lys'venskii Mining District of the Heirs of Count P. P. Shuvalov." Notwithstanding that some of the mines were worked by means of dredges, endless chain elevators, Archimedean screws, and other improved apparatus, almost 80 per cent of the platinum was secured in 1914 by hand working, and one-third of the production was secured by starateli.

In the five-year period, 1909–1913, the output of the Krestovozdvizhen mines fell continually. The growth in output for 1914 was caused by an increase in the production of three dredges and the introduction of steam shovels. Of the entire quantity of platinum acquired in 1914 (38,050 ounces), 8,150 ounces were gotten by the help of dredges and 29,900 ounces by hand labor.

In the Sievero-Verkhotur (North Verkhotur) district platinum was produced in only 9 mines; in the Nikolae-Pavdinsk district,



Map of the Mining Region of the Urals (Copied from an Official Russian Map)

Borders of governments — - — - — -
Rivers ———
Railroads — — — — —
Platinum mines —

in 3 mines; in the Iuzhno-Zaozer district in 1 mine; in the Lialia crown area in 1 mine; in the Znamen crown area in 3 mines; and there was 1 mine on the land of the peasant owners. The decrease of output for 1913 and 1914 for this district was caused by the curtailment of work by the starateli since they have been, in the places formerly worked by them, gradually replaced by dredges. Thus the yield of platinum diminished by 3,950 ounces in 1914. This decrease fell entirely on the mines of the Nikolae-Pavdinsk district, where in the beginning of operations for 1914 the work of starateli was stopped altogether. These had formerly produced most of the platinum obtained. Dredges obtained 2,370 ounces of the platinum output in this district in 1914.

In the Cherdyn district are located the mines of Prince Abamelek-Lazarev, which are situated on the Mala and Bolshaia Kos'va rivers (Little and Big Kos'va) and the Tylai, as well as the mines of four "possessors," Count Stroganov, Count Balashdv, Prince Golitzen, and Prince Abamelek-Lazarev, located in the Verkh-Iaiven area. The output of the district decreased from 1912 to 1914, though the same mines were worked in 1913 and 1914. The decrease of yield was shown by all the mines except the Mala-Kos'vin belonging to Abamelek-Lazarev.

In the Iuzhno (South)-Ekaterinburg district the output of platinum is very small. Besides that recovered in this district there was also an insignificant quantity of platinum (3.7 ounces) secured in the Sievero-Ekaterinburg district as a by-product in working the gold mines.

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THE PREPARATION OF SEVERAL USEFUL SUBSTANCES FROM CORN COBS[1]

By F. B. LaForge and C. S. Hudson

It has been shown by Hudson and Harding[2] that corn cobs yield about 12 per cent crystalline xylose through acid hydrolysis. The strength of acid employed was 7 per cent sulfuric and the hydrolysis was carried out by several hours' boiling. We undertook to determine whether this acidity could not be decreased considerably by carrying out the hydrolysis at a higher temperature in an autoclave. This proves to be possible with an acidity as low as $1^3/_4$ per cent at a temperature of 130°, and there is thereby opened up a way for the preparation of crystalline xylose on a commercial basis. It was noticed that a volatile acid is produced in noteworthy amount along with the xylose during the hydrolysis of the corn cobs, and the identification of this acid as acetic indicates that it may be a valuable by-product in the preparation of xylose from corn cobs. A strength of 1 to 2 per cent sulfuric acid appears to be necessary in order to obtain a good yield of xylose. If the acidity is lower there is little sugar produced, although a considerable quantity of the corn cobs passes into solution. Indeed, there may be extracted from corn cobs by water alone, at the somewhat higher temperature of 140° to 160°, a water-soluble gum which is probably a form of xylan. However, its hydrolysis by acids yields xylose in only moderate proportions, accompanied by a sirupy mother liquor which does not crystallize. It was therefore sought to remove this gum from the corn cobs by water digestion in order that the subsequent acid hydrolysis of the residue might yield xylose with a smaller proportion of uncrystallizable sirup. This has proved possible and in addition it has been found that the gum has excellent properties as an adhesive which render it a useful product. The solid residue that remains from the corn cobs after acid hydrolysis consists principally of cellulose. It is very absorbent and might be used as an ingredient in molasses, stock feeds, possibly also as an absorbent for nitroglycerin in the manufacture of dynamite, and for other such purposes. It has been found that it is readily gelatinized by 70 to 75 per cent sulfuric acid and may then be hydrolyzed to glucose after dilution with water, according to well-known methods. The glucose so produced crystallizes well and could doubtless be used in the same ways that crystalline glucose from starch is employed. The manufacture of alcohol by the fermentation of corn-cob glucose appears possible provided sulfuric acid is obtainable cheaply.

Direct uses for xylose, as such, seem difficult to find. Its possible food value needs investigation because it is probably

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[1] Contents of Address presented before the New York Section of the American Chemical Society, May 10, 1918, by F. B. LaForge.

[2] *J. Am. Chem. Soc.*, **39** (1917), 1038.

oxidized to some extent, especially by herbivorous animals, but the limit of tolerance is not known. Xylose is about half as sweet as cane sugar. Its after-taste is not bitter, as is that of mannose, for instance, and if uses for xylose as human food could be established its taste is in its favor. It is well known that xylose may be converted by the cyanhydrin synthesis to gulonic lactone. We would call attention to the suggestion that such lactones of the sugar group may furnish an excellent material for use as a crystalline acid ingredient in baking powders. Gulonic lactone stands out prominently as suitable for such uses, because of its ease of crystallization and the fact that it can be produced fairly cheaply from xylose. We have made experiments with mixtures of gulonic lactone and bicarbonate of soda and find that a very satisfactory baking powder may be so prepared. The preparation of gulonic lactone from xylose has been made by a method that is more satisfactory than that usually employed. It will be described in a separate paper by one of us (L.).

We will now describe in detail the preparation from corn cobs of the various useful substances that have been mentioned.

PREPARATION OF ADHESIVE GUM

The coarsely broken cobs are placed in an autoclave with sufficient water to cover them. The contents are then heated to 140°, and the temperature then raised to 160° during one hour. After cooling below the boiling point of water the autoclave is opened and the contents removed. The liquid in the autoclave is almost fully absorbed by the dry cobs in the process of heating. The next step consists in the extraction of the solution from the solid residue in which it is absorbed; this is accomplished by subjecting the wet material to strong pressure. The solution thus obtained is evaporated in an open kettle to the consistency of a thick sirup, which constitutes the adhesive gum. It is ready for use without further treatment, and is recommended as a cheap adhesive in the fiber board and paper-box industry, in bill posting, labeling, etc. The use of this substance in place of starch, dextrine, and flour paste would make possible an enormous saving of these foodstuffs.

The solid residue which is left in the press serves for the preparation of other products which are described below.

PREPARATION OF XYLOSE AND ACETIC ACID

For the preparation of the sugar, xylose, and of acetic acid the residue from the preparation of the adhesive gum is treated as follows:

An autoclave, such as was used in the preparation of the adhesive, is filled to about three-fourths of its capacity with the solid residue from the pressing operation above referred to. A solution of sulfuric acid containing about one and three-quarters per cent of acid is added in sufficient quantity to cover the solid material in the container. Heat is then applied and the temperature of the contents of the apparatus raised to 130° C. where it is maintained for one hour. This treatment causes the liberation and solution of xylose and acetic acid. After cooling, the contents of the autoclave are removed and subjected to pressure to expel the solution from the undissolved solid material. This solution is then heated in contact with a second charge as before and thus a solution containing approximately double the amounts of xylose and acetic acid in a given volume is obtained. To isolate the acetic acid from this solution some of the steam from the heated autoclave is allowed to escape through a condenser and the distillate collected. This weak solution of acetic acid may be built up or fortified by causing it to pass through several such operations as just described, using the weak acetic acid solution instead of water as in the first instance. In this manner more and more acetic acid is accumulated in a given volume until the desired strength of acid is reached. This concentration may be made to attain 5 or 6 per cent.

The xylose solution remaining in the autoclave after the second heating operation is separated by pressure from the solid residue in which it is absorbed and from this solution the sugar is obtained. To accomplish the isolation of the xylose the solution referred to is evaporated under diminished pressure to a thick sirup which is seeded with xylose and left for itself for about 12 hours. In order to obtain crystals of sufficient size to separate from the mother liquor by means of a centrifuge the following conditions must be observed: First, the solution should be concentrated without undue delay; second, the proper consistency, which is about that of ordinary commercial molasses, should be attained; third, crystallization should take place at a temperature not lower than 20° nor higher than 35° C.; fourth, after crystallization has been induced by seeding, no more sirup should be added to the magma.

The solid residue from the pressing operations above referred to, which consists chiefly of crude cellulose, may be used in the preparation of stock feed.

For this purpose the press cake is coarsely ground, mixed with a small amount of lime or soda to neutralize the slight amount of sulfuric acid which it contains, and in this state is mixed with any desired amount of molasses or other sirup and dried by any suitable means. Such a mixture, if fed in connection with seed press-cake meal, may constitute cheap and good feed for cattle or other animals.

A second use to which the crude cellulose residue may possibly be put is that of an absorbent for nitroglycerin in the manufacture of dynamite. For this purpose the material must be purified by washing with dilute caustic soda to remove a brown material present as an impurity. The excess of the reagent must be removed from the cellulose by washing with water.

The cellulose may also be of use in the manufacture of artificial silk, leather substitutes, filaments, and plastics, by any of the processes now in common use. Other uses to which the impure cellulose residue may be put are the manufacture of glucose and of alcohol.

PREPARATION OF GLUCOSE FROM CRUDE CORN-COB CELLULOSE

The residue of impure cellulose above referred to, from which gum and xylose have been removed as already described, is ground to a rather fine powder and intimately mixed with about an equal weight of sulfuric acid of about 75 per cent strength. In determining the strength of acid to be used allowance should be made for the small amount of moisture left in the cake after the pressing operation. The resulting mixture is a stiff dough which is black in color. After the "dough" has been allowed to stand at room temperature for about 6 hrs., it is mixed with a convenient amount of water (5 to 8 parts), and the mixture is boiled for about one hour, after which the undissolved solid residue is removed from the very slightly colored solution by means of a filter press. Slaked lime which has been sifted free from lumps and suspended in water is added to the filtrate in quantity sufficient to very nearly neutralize the free acid in the solution. The calcium sulfate which separates out on this treatment is removed by means of a centrifuge or filter press. The solid residue of calcium sulfate is washed with water and the washings are added to the filtrate. The resulting liquid is a dilute solution of glucose. This solution is added to a second portion of ground press cake which has been treated with sulfuric acid as above described and the subsequent operations of boiling, filtering, etc., repeated as before. This process may be again repeated until the sugar content of the solution has been increased to the desired degree.

In order to isolate the glucose in the crystalline state the final solution is exactly neutralized with lime, filtered, and concentrated to a thick sirup. This sirup soon crystallizes to a solid mass. Glucose prepared after this manner has a slight brown color but is free from any objectionable taste and can be used directly as an ingredient of stock feed.

In case the product were to be used for human food, very pure sulfuric acid and lime would have to be used in this preparation and decolorizing carbon or bone char would doubtless have to be employed.

The glucose solution above referred to is very rapidly and completely fermented by yeast and hence could be used for the production of alcohol.

By the process above described, about 50 per cent of the weight of the crude corn-cob cellulose is converted into glucose.

The solid residue from the first treatment of the material which was removed by the filter press, may again be subjected to digestion with 75 per cent sulfuric acid, as was the original material, and again a yield of 50 per cent of its weight of glucose may be obtained by the above process, making the total yield 75 per cent, or 37.5 per cent of the weight of the corn cob.

From two tons of sulfuric acid of the above-mentioned strength one ton of glucose could be prepared. In order to compete with glucose or molasses from other sources for the manufacture of alcohol, sulfuric acid of 75 per cent strength would have to be obtained at a price not much greater than $8.00 per ton.

CONCLUSION

While the methods for obtaining these principal products from corn cobs have not as yet been tested out on a large factory scale, they can be said to be already out of the laboratory stage, since the work has been carried on by means of autoclaves, powerful presses, vacuum stills, centrifuges, etc.

The yields of the various products constitute approximately the following percentages of the weight of the dry corn cobs:

Product	Per cent
Adhesive Gum	30
Crystalline Xylose	5
Acetic Acid	2.5 to 3
Crystalline Glucose	37

The United States is the world's greatest producer of corn. Our annual crop ranges from $2\frac{1}{2}$ to 3 billion bushels, and represents nearly 75 per cent of the world's production. Other countries which rank as great corn producers are Austria-Hungary, Mexico, Argentine, and Italy. For every bushel of corn there is approximately a bushel of cobs which, however, weigh only one-fourth as much as the grain. Corn cobs are not utilized to any great extent. They have a certain value as fuel and also have been used as an ingredient of stock feeds. They contain, however, little or nothing that is directly available for animal nutrition. They are one of the great waste products of our agriculture. We believe, however, that the methods of utilizing them which have been described in this article may eventually render them a valuable source of raw material for manufacturing.

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STATISTICS OF GARBAGE COLLECTION AND GARBAGE GREASE RECOVERY IN AMERICAN CITIES

By Raymond Pearl

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In July 1917, the writer inaugurated in the Statistical Division of the United States Food Administration a system of voluntary statistical returns from the leading cities in the country, regarding the amount of garbage collected monthly and, where possible, the amount of grease recovered from the garbage collected. The purpose underlying the plan was to obtain information which would serve the officials of the Food Administration as an index of the effectiveness of their propaganda campaign urging the people to avoid waste in the preparation and use of food. In view of the somewhat novel character of the statistical material which has been collected in this work, it seems desirable to give it permanent record by publishing it where it will be available to public health officials and others who may be interested. Accordingly there is presented here the records of two complete years, from May 1916 to April 1918, inclusive.

The statistical material was obtained through the voluntary coöperation of municipal officials. In the first instance the mayors of all the larger cities in the country were asked if they would not arrange to have the proper official in their municipalities make a monthly report to the Food Administration on the amount, in tons, of garbage collected each month in the current year and the corresponding month of the previous year, beginning with May 1917. The response was very gratifying, particularly in regard to the willingness, not to say eagerness, to coöperate, of those asked. In a rather considerable number of cases it developed, apparently quite as much to the astonishment of the city officials as to ours, that the city had no record, nor any ready method of finding out how much garbage was collected in that city in a given interval of time. Finally, however, we were able to get 96 cities, with an estimated aggregate population of over 26,000,000 reporting regularly and for each month in the 2 years from May 1916 to May 1918. These cities include roughly about one-fourth of all the people living in this country. The numbers are sufficiently large to give considerable trustworthiness to the data as indicative of urban conditions in the country in general. The statistics are certainly much more comprehensive in their scope than any garbage statistics for the United States that have hitherto been brought together, so far as the writer is aware.

At the end of the year a tabulation of all the monthly returns which had been made was returned to the reporting city official for verification or correction. In this way it is believed that the figures here given are accurate so far as concerns the reporting of the municipal records. The original records themselves in some cases obviously do not include the whole of the garbage produced. In a few they are grotesquely far from the mark. It is, for example, inconceivable that the hundred odd thousand people who live in Nashville, Tenn., *produce* only about 400 tons of garbage in a year, while about an equal number, say 10,000 fewer, of people living in Norfolk, Va., produce in the neighborhood of 30,000 tons in a year. The fact is that the figures given in this paper refer to tonnage of garbage officially *collected* either by or under the official control of the municipality so that the amount is a matter of city record. Only in cities where by ordinance it is forbidden to dispose of garbage in any other way than by delivery to the organized official collecting agency of the city can the statistics here given be regarded as representing the total amount produced.

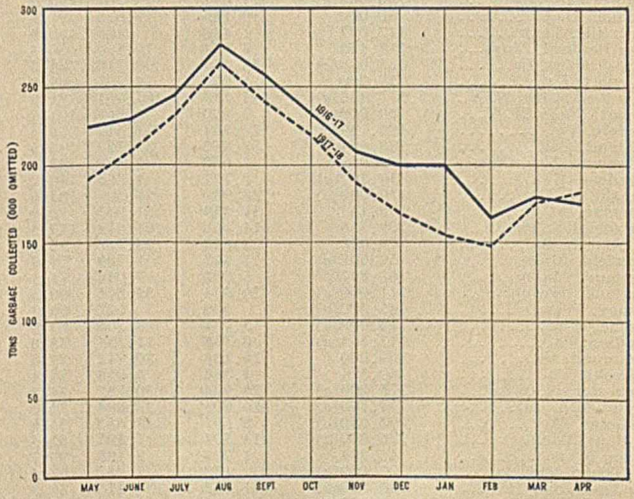

Fig. I—The Seasonal Curve of Garbage Production, Based on Average Returns from 96 Largest Cities

TABLE I

Total Garbage Collections, by Tons, from 96 Cities for the 2 Years May 1917–April 1918 and May 1916–April 1917

CITY	Population	TONS COLLECTED		Relative figure 1917–18 to 1916-17 taken as 100
		May 1917–April 1918	May 1916–April 1917	
Akron, Ohio	150,000(*a*)	10,084	8,529	118.2
Allentown, Pa	80,000(*a*)	12,591	12,340	102.0
Atlanta, Ga	196,000(*a*)	42,412	44,798	94.7
Atlantic City, N. J.	57,660	15,373	18,792	81.8
Augusta, Ga	41,040	47,480	49,338	96.2
Aurora, Ill	33,022	1,509	1,805	83.6
Baltimore, Md	593,000(*a*)	34,685	37,915	91.5
Berkeley, Cal	66,000(*a*)	8,874	9,726	91.2
Boston, Mass	781,628(*a*)	46,335	52,650	88.0
Bridgeport, Conn	172,113(*a*)	18,166	19,897	91.3
Brockton, Mass	67,449	4,117	5,794	71.1
Buffalo, N. Y	468,558	15,382	21,817	70.5
Cambridge, Mass	112,981	7,138	7,605	93.9
Cedar Rapids, Iowa	40,667(*d*)	2,282	2,230	102.3
Charleston, S. C	61,041(*b*)	26,900	32,114	83.8
Charlotte, N. C	50,000(*a*)	9,410	8,612	109.4
Chelsea, Mass	47,000(*a*)	1,746	2,455	71.1
Chicago, Ill	2,497,722	93,235	124,496	74.9
Cincinnati, Ohio	416,300(*a*)	34,103	40,692	83.8
Cleveland, Ohio	674,073	55,466	59,708	92.9
Colorado Springs, Col.	36,000(*a*)	3,832	3,974	96.4
Columbus, Ohio	220,000(*a*)	17,295	20,393	84.8
Dallas, Texas	124,537	220	267	82.4
Dayton, Ohio	155,000(*a*)	15,677	16,621	94.3
Detroit, Mich	750,000	64,270	72,785	88.3
East Orange, N. J.	39,852	3,746	3,980	94.1
El Paso, Texas	85,222(*a*)	15,948	15,969	99.9
Erie, Pa	100,000(*a*)	6,927	8,257	83.9
Everett, Mass	40,000(*a*)	1,750	1,975	88.6
Fort Wayne, Ind	81,057(*a*)	7,862	10,203	77.1
Galveston, Texas	35,000(*b*)	6,954	11,858	58.6
Grand Rapids, Mich	140,000(*a*)	7,339	8,678	84.6
Hartford, Conn	145,000(*a*)	13,829	14,644	94.4
Haverhill, Mass	51,870(*a*)	3,541	3,852	91.9
Holyoke, Mass	62,301(*b*)	1,708	2,310	73.9
Houston, Texas	165,192(*a*)	30,203	28,567	105.7
Indianapolis, Ind	271,758	19,929	23,267	85.7
Jacksonville, Fla	100,000(*a*)	17,654	24,732	71.4
Jersey City, N. J.	316,889(*b*)	106,846	106,856	100.0
Joliet, Ill	40,000(*a*)	3,232	3,636	88.9
Kansas City, Mo	297,847	1,730	1,860	93.0
Lexington, Ky	41,097(*c*)	1,985	2,607	76.1
Los Angeles, Cal	600,000	47,345	51,062	92.7
Lowell, Mass	107,978(*a*)	3,935	4,272	92.1
Lynn, Mass	102,425	8,591	10,153	84.6
Manchester, N. H.	85,000(*a*)	4.477	7,868	57.0
Memphis, Tenn	148,995	15,231	17,146	88.8
Milwaukee, Wis	474,000(*a*)	30,008	35,928	83.5
Minneapolis, Minn	390,000(*a*)	21,041	23,307	90.3
Mobile, Ala	60,060	19,145	19,655	97.4
Nashville, Tenn	117,057	410	406	100.9
New Bedford, Mass	118,158	8,774	10,162	86.3
New Orleans, La	385,000(*a*)	83,459	98,710	84.5
Newport, Ky	32,000	1,906	2,726	69.9
New York City, N. Y.	5,377,456(*a*)	445,237	487,451	91.3
Niagara Falls, N. Y.	60,000(*a*)	2,900	2,865	101.2
Norfolk, Va	106,159(*b*)	27,251	31,512	86.5
Oakland, Cal	198,604	32,610	33,787	96.5
Oklahoma City, Okla.	92,943	2,658	2,854	93.1
Pasadena, Cal	46,500(*a*)	2,727	1,865	146.2
Passaic, N. J.	70,000(*a*)	28,987	27,599	105.0
Paterson, N. J.	138,443	31,359	31,985	98.0
Philadelphia, Pa	1,709,518	114,160	101,678	112.3
Pittsburgh, Pa	579,090	72,612	73,758	98.4
Pittsfield, Mass	39,607(*a*)	1,418	1,789	79.3
Portland, Maine	63,867	5,012	7,046	71.1
Portland, Oregon	311,000(*a*)	30,674	33,876	90.5
Quincy, Mass	45,500(*a*)	506	627	80.7
Racine, Wis	48,000(*a*)	3,751	4,268	87.9
Reading, Pa	112,561(*a*)	8,546	11,584	73.8
Richmond, Va	160,000	26,188	30,942	84.6
Roanoke, Va	40,574	4,568	6,058	75.4
Rochester, N. Y	275,000(*a*)	25,926	30,782	84.2
Sacramento, Cal	77,500(*a*)	16,901	23,894	70.7
St. Louis, Mo	905,650(*a*)	8,657	44,555	86.8
St. Paul, Minn	276,000(*a*)	14,593	17,105	85.3
Salem, Mass	46,994	1,994	2,198	90.7
San Diego, Cal	92,000(*a*)	173	257	67.3
San Francisco, Cal	550,000(*a*)	131,653	150,415	87.5
San José, Cal	40,000	4,549	4,976	91.4
Savannah, Ga	68,805	9,262	11,516	80.4
Schenectady, N. Y.	105,000	4,111	4,419	93.0
Scranton, Pa	146,811	12,698	15,518	81.8
Somerville, Mass	90,500(*a*)	5,870	5,875	99.9
Springfield, Ill	70,000(*a*)	47,910	28,315	169.2
Springfield, Mass	105,942	10,394	11,640	89.3
Syracuse, N. Y	155,624	12,895	14,055	91.7
Tampa, Fla	53,886	18,081	18,023	100.3
Terra Haute, Ind	66,083	11,730	19,631	59.8
Toledo, Ohio	220,000(*a*)	22,180	23,971	92.5
Trenton, N. J	111,593(*c*)	14,751	16,166	91.2
Washington, D. C.	400,000(*a*)	46,732	46,293	100.9
Wheeling, W. Va	50,671	4,603	5,658	81.4
Wilmington, Del	94,265	18,986	14,187	133.8
Worcester, Mass	187,000(*a*)	6,992	6,828	102.4
Youngstown, Ohio	120,000(*a*)	8,424	9,827	85.7
TOTAL	26,034,685	2,388,932	2,609,134	90.1

(*a*) Population in 1918. (*b*) Population in 1917.
(*c*) Population in 1916. (*d*) Population in 1915.

The fact that the figures are for collection rather than production does not invalidate relative comparisons of one year with another, provided of course that the scope of official collection did not change in the period. Pains have been taken to make sure by correspondence that no such changes in the plan of collection came in in the cities dealt with during the period covered.

The basic statistics are contained in Table I, in which the 96 cities covered are listed alphabetically. The data given are (*a*) population, (*b*) gross tonnage of garbage collected in 1917–18, (*c*) gross tonnage of garbage collected in 1916–17, fiscal year ending April 30 being taken in both cases, (*d*) a relative figure which expresses the 1917–18 collection as a percentage of the 1916–17 collection for the same city.

The totals of this table show that in the 96 cities included in the tabulation 10 per cent less garbage was collected in 1917–18 than in the previous year. The figures demonstrate a genuine conservation of food by the urban population of the country during the past year, in the sense that 10 per cent of the usual wastage in the preparation of food and in the incomplete usage of food after its preparation was eliminated. The gross tonnage figures do not, however, give a true picture of the real amount of conservation or of the effectiveness of the Food Administration's teachings. This can only be demonstrated by the grease figures to which we shall come presently.

Of the 96 cities included in Table I, 81 showed smaller collections in 1917–18 than in 1916–17, and 15 had larger collections. The distribution of relative figures for these 81 cities was that shown in Table II.

TABLE II

Distribution of Relative Figures of Cities Showing Smaller Collections in 1917–18 than in 1916–17

Relative Figure	Number of Cities
50–59	2
60–69	2
70–79	14
80–89	31
90–99	32

Roughly speaking, three-fourths of these 81 cities had relative figures of 80 or above, indicating reduction of collections from 1 to 20 per cent. The four cities giving relative figures under 70, namely, Manchester, N. H., Galveston, Texas, Terre Haute, Ind., and San Diego, Cal., make very creditable showings indeed.

The 15 cities showing an increase in garbage collections in 1917–18 are separately treated in Table III, which has the same arrangement as Table I.

TABLE III

Fifteen Cities in which the Annual Garbage Collections Increased in 1918 Relative to 1917, in Order of Increase

Order	CITY	TONS COLLECTED		Relative figure 1917–18 to 1916–17 taken as 100
		May 1917–April 1918	May 1916–April 1917	
1	Tampa, Fla	18,081	18,023	100.3
2	Nashville, Tenn	410	406	101
3	Washington, D. C	46,732	46,293	101
4	Niagara Falls, N. Y	2,900	2,865	101
5	Allentown, Pa	12,591	12,340	102
6	Cedar Rapids, Iowa	2,282	2,230	102
7	Worcester, Mass	6,992	6,828	102
8	Passaic, N. J	28,987	27,599	105
9	Houston, Texas	30,203	28,567	106
10	Charlotte, N. C	9,420	8,612	109
11	Philadelphia, Pa	114,160	101,678	112
12	Akron, Ohio	10,084	8,529	118
13	Wilmington, Del	18,986	14,187	134
14	Pasadena, Cal	2,727	1,865	146
15	Springfield, Ill	47,910	28,315	169

Of these 15 cities, the first seven may at once be dropped out of account as the increase is very small, 2 per cent or less. Of the remainder, 5, namely Passaic, Philadelphia, Akron, Wilmington and Springfield, Ill., are places which have received considerable increments of population within the last year on account of war activities of one sort or another, such as munition making and the like. The effect of such sudden increase in population on garbage collection is obvious. To show its effect in detail, Table IV has been prepared, which gives the monthly collections for the four industrial cities showing the greatest increases in garbage collections.

TABLE IV

The 4 Industrial Cities Showing the Greatest Increase in Garbage Collection in 1918 Relative to 1917, Giving Collections by Months

	Springfield, Ill.		Wilmington, Del.		Akron, Ohio		Philadelphia, Pa.	
	Tons collected	Relative	Tons collected	Relative	Tons collected	Relative	Tons collected	Relative
May 1917	3,690	293	923	77	1,005	172	8,017	102
May 1916	1,260	...	1,203	...	583	...	7,823	...
June 1917	3,528	280	970	83	894	148	9,588	119
June 1916	1,260	...	1,165	...	604	...	8,053	...
July 1917	2,322	158	1,200	93	864	105	11,042	131
July 1916	1,474	...	1,287	...	825	...	8,434	...
Aug. 1917	2,393	224	4,120	222	1,094	113	14,883	140
Aug. 1916	1,068	...	1,853	...	967	...	10,604	...
Sept. 1917	919	124	3,582	208	1,165	118	13,690	142
Sept. 1916	742	...	1,722	...	985	...	9,665	...
Oct. 1917	2,745	235	1,436	97	1,069	129	11,183	132
Oct. 1916	1,170	...	1,476	...	828	...	8,498	...
Nov. 1917	2,650	142	1,995	183	792	96	8,174	107
Nov. 1916	1,872	...	1,089	...	829	...	7,655	...
Dec. 1917	3,438	102	1,282	139	630	122	6,647	90
Dec. 1916	3,375	...	925	...	515	...	7,423	...
Jan. 1918	2,217	58	927	106	539	102	7,928	103
Jan. 1917	3,792	...	876	...	528	...	7,702	...
Feb. 1918	3,220	66	743	89	576	133	7,054	67
Feb. 1917	4,912	...	838	...	432	...	10,559	...
Mar. 1918	11,280	253	799	84	698	114	7,962	101
Mar. 1917	4,450	...	952	...	613	...	7,879	...
Apr. 1918	9,508	323	1,009	126	759	93	7,992	108
Apr. 1917	2,940	...	801	...	820	...	7,374	...

Table V gives the monthly collections in the 10 largest cities covered in the statistics, with the relative figures for each month, comparing that month in 1917–18 with the corresponding month in 1916–17.

TABLE V

Garbage Collections from the 10 Largest Cities, Giving Comparisons by Months

	New York, N. Y.		Chicago, Ill.		Philadelphia, Pa.		St. Louis, Mo.		Boston, Mass.		Cleveland, Ohio		Los Angeles, Cal.		Baltimore, Md.		Pittsburgh, Pa.		San Francisco, Cal.	
	Tons collected	Relative	Tons collected	Relative	Tons collected	Relative	Tons collected	Relative	Tons collected	Relative	Tons collected	Relative	Tons collected	Relative	Tons collected	Relative	Tons collected	Relative	Tons collected	Relative
May 1917	36,602	81	2,990	27	8,017	102	2,794	70	4,416	89	4,165	74	3,451	91	2,886	96	5,490	88	10,803	87
May 1916	45,197	...	11,177	...	7,823	...	3,997	...	4,980	...	5,660	...	3,812	...	3,006	..	6,244	...	12,438	..
June 1917	44,590	93	8,386	65	9,588	119	3,882	92	4,042	88	4,613	89	3,454	84	3,199	97	6,019	95	10,211	87
June 1916	48,099	...	12,826	...	8,053	...	4,205	...	4,572	...	5,176	...	4,120	...	3,307	..	6,303	...	11,760	..
July 1917	49,295	94	11,239	79	11,042	131	4,631	84	3,870	87	5,431	90	4,453	83	4,854	97	6,728	99	10,318	85
July 1916	52,173	...	14,302	...	8,434	...	5,540	...	4,440	...	6,068	...	5,337	...	5,012	..	6,810	...	12,078	..
Aug. 1917	51,545	97	12,583	78	14,883	140	6,247	88	4,265	91	5,680	89	5,431	95	5,063	93	7,340	96	11,846	86
Aug. 1916	53,368	...	16,093	...	10,604	...	7,078	...	4,680	...	6,384	...	5,729	...	5,473	..	7,652	...	13,780	..
Sept. 1917	45,903	94	12,142	82	13,690	142	5,591	99	4,310	92	5,639	93	5,167	101	4,567	97	7,623	102	11,121	82
Sept. 1916	48,934	...	14,774	...	9,665	...	5,645	...	4,668	...	6,069	...	5,111	...	4,709	..	7,481	...	13,541	..
Oct. 1917	42,971	96	11,259	90	11,183	132	3,815	94	4,033	87	5,955	109	4,440	97	3,833	97	7,440	106	11,861	88
Oct. 1916	44,629	...	12,462	...	8,498	...	4,075	...	4,632	...	5,473	...	4,596	...	4,041	..	7,045	...	13,482	..
Nov. 1917	35,551	90	8,967	93	8,174	107	2,495	81	3,631	83	4,580	92	3,395	90	2,099	95	5,877	97	10,926	90
Nov. 1916	39,299	...	9,663	...	7,655	...	3,081	...	4,368	...	4,973	...	3,779	...	2,216	..	6,034	...	12,173	..
Dec. 1917	28,739	83	6,661	91	6,647	90	1,896	74	3,415	79	4,165	104	3,481	90	1,787	89	4,613	79	11,414	86
Dec. 1916	34,691	...	7,280	...	7,423	...	2,575	...	4,332	...	4,012	...	3,862	...	2,011	..	5,840	...	13,347	..
Jan. 1918	24,935	76	2,388	30	7,928	103	1,362	57	2,910	63	3,751	84	3,605	90	1,780	76	4,095	69	11,537	84
Jan. 1917	32,975	...	7,897	...	7,702	...	2,403	...	4,608	...	4,485	...	4,026	...	2,357	..	5,907	...	13,696	..
Feb. 1918	22,350	85	4,347	74	7,054	67	1,498	90	3,093	81	3,352	100	3,246	93	985	52	5,362	117	10,211	90
Feb. 1917	26,399	...	5,904	...	10,559	...	1,668	...	3,812	...	3,366	...	3,498	...	1,899	..	4,586	...	11,313	..
Mar. 1918	29,283	98	6,051	102	7,962	101	2,011	100	4,175	103	3,552	87	3,721	99	1,769	93	5,988	132	10,800	89
Mar. 1917	29,995	...	5,936	...	7,879	...	2,020	...	4,051	...	4,087	...	3,740	...	1,905	..	4,539	...	12,092	..
Apr. 1918	33,650	106	6,222	101	7,992	108	2,434	107	4,175	119	4,583	116	3,501	101	1,763	89	6,037	114	10,605	99
Apr. 1917	31,692	...	6,182	...	7,374	...	2,268	...	3,507	...	3,955	...	3,452	...	1,979	..	5,317	...	10,715	..

The first noteworthy feature of this table is the considerable variation among the different cities as to the constancy of the relative figure for the different months of the year. In some of the cities it maintains a fairly even level throughout the year, notably in Baltimore and San Francisco, and to a lesser degree, Boston. The seasonal fluctuations in savings in these cities, as indicated by the relative figures, follow rather closely the *general* seasonal distribution of the garbage collections in the cities named. Others of the cities show widely varying figures in this respect, notably in Philadelphia, where, in the course of the year, the relative figure changes all the way from 57 to 142.

Some general features of the seasonal distribution of garbage collection are indicated in Table V. The normal seasonal curve of garbage production, however, is better shown by the sums by months of all the cities covered in Table I. This is done in Table VI, where there are exhibited the total collections of garbage for the 96 cities reporting, in each month of the two fiscal years for which reports are available.

TABLE VI

Total Tons of Garbage Collected in 96 Cities, by Months, May 1916 to April 1918

	Garbage Collected (tons) 1917–18	Garbage Collected (tons) 1916–17	Relative
May	191,129.06	226,066.56	85
June	209,937.90	230,724.72	91
July	233,853.45	245,198.66	95
August	265,409.63	278,948.91	95
September	241,317.59	258,751.64	93
October	220,943.29	234,148.73	94
November	190,012.89	209,090.07	91
December	170,391.67	200,067.75	85
January	156,711.35	200,096.45	78
February	148,785.15	167,391.84	89
March	177,392.25	181,306.00	98
April	183,119.69	177,342.50	103
Totals	2,388,931.92	2,609,133.83	92

From this diagram and table it is possible to get considerable information as to the normal distribution of the garbage production in the different months of the year. The month of maximum collection is August and the month of minimum collection is February. Following February, the curve begins to rise and goes up rather steadily along something approaching a straight line to the maximum point. The fall from the maximum point in May to the minimum point in February is again nearly a straight line.

Table VI also enables one to see in what month the conservation propaganda has been the most effective. In the months of May and June and December and January, the degree or extent of the lowering of the 1917–18 collections, as compared with the 1916–17 collections, is largest. During the other months of the year the curves run very closely parallel. During the last month of the fiscal year the two curves cross; that is to say, the April 1918 collections were slightly larger than the April 1917 collections. This is probably due chiefly to the fact of an increased use in April 1918 of various vegetable foods with a comparatively large amount of inedible refuse, which increases in turn resulted from the shortage of wheat and wheat flour. People were urged to substitute and undoubtedly did so to a very considerable extent, vegetables for the scant cereals. This was particularly true of potato consumption. Another factor in the case is undoubtedly the increase of the population in a considerable number of the cities of the United States as a result of the war conditions, munitions making, shipbuilding, etc.

We may turn now to a consideration of the grease recovery from garbage. The grease is the profitable constituent of garbage as it is ordinarily handled. The raw material also, of course, contains valuable protein and carbohydrate, but in the usual methods of reduction the tankage from which the grease has been extracted goes to fertilizer. Unfortunately, only

TABLE VII

Tons of Garbage Grease Recovered in 12 Cities for the 2 Years May 1917–April 1918 and May 1916–April 1917

		TONS OF GARBAGE		TONS OF GREASE RECOVERED			PERCENTAGE OF GREASE		
CITY	Population	May 1917–April 1918	May 1916–April 1917	May 1917–April 1918	May 1916–April 1917	Relative Figure	May 1917–April 1918	May 1916–April 1917	Relative Figure(b)
Boston, Mass.	781,628(a)	46,335	52,650	1,401	2,140	65	3.02	4.06	74
Buffalo, N. Y.	468,558	15,382	21,817	314	494	63	2.03	2.26	90
Chicago, Ill.	2,497,722	93,235	124,496	1,656	2,869	58	1.77	2.30	77
Cleveland, Ohio	674,073	55,466	59,708	1,415	1,821	78	2.55	3.05	84
Columbus, Ohio	220,000(a)	17,295	20,393	354	639	55	2.04	3.13	65
Dayton, Ohio	155,000(a)	15,677	16,621	250	355	70	1.59	2.13	75
Indianapolis, Ind.	271,758	19,929	23,267	454	793	57	2.27	3.40	67
New Bedford, Mass.	118,158	8,774	10,162	199	270	74	2.26	2.65	85
Pittsburgh, Pa.	579,090	72,612	73,758	1,554	2,117	73	2.14	2.87	75
Philadelphia, Pa.	1,709,518	114,160	101,678	1,178	1,161	101	1.03	1.14	90
Schenectady, N. Y.	105,000	4,111	4,419	84	91	93	2.04	2.04	100
Wilmington, Del.	94,265	18,986	14,187	49	92	53	0.25	0.65	38
Totals	7,684,771	481,962	523,156	8,906	12,843	70	1.85	2.45	76

(a) Population 1918.

(b) Relative figure expressing the monthly collection for the present year as a percentage of that of the same month last year; that is, relative figures under 100 mean smaller collections and figures over 100 mean larger collections.

comparatively few cities have municipal reduction plants and are able to furnish statistics of grease recovery. Such data as it has been possible to collect are exhibited in Table VII. The arrangement is the same as that of the earlier tables in this paper.

The data of Table VII show in the clearest manner the remarkable effect of the conservation campaign. The 12 cities show a reduction of 30 per cent in the gross tonnage of grease recovered from garbage in 1917–18 as compared with 1916–17. The average percentage of grease in the garbage dropped from 2.45 to 1.85. The figures demonstrate that not only was there a quantitative conservation of food affected during the last year, but also, and even more important, there was a proportionally much greater qualitative conservation. There must have been in these 12 cities a very great reduction in the amount of meats and fats going into the garbage can.

The two cities showing the greatest qualitative food conservation, as indicated in garbage statistics, were Columbus, Ohio, and Wilmington, Del., with relative figures of 55 and 53, respectively. In these two cities the garbage in 1917–18 contained only a little more than half as much fatty material in 1917–18 as in 1916–17. This is truly a remarkable record.

Putting all the data together, it appears that, in so far as the sampling of cities may be considered representative of the urban portion of the country as a whole, there has been a substantial conservation of food by the American people during the past year. A reduction of 10 per cent in the gross tonnage of garbage, and of 30 per cent in the tonnage of fat recovered can only have been accomplished by a real and widespread saving and utilization of food materials which ordinarily go into the garbage can.

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COTTON OIL INDUSTRY IN THE WAR[1]

By DAVID WESSON

Many things have been turned upside down by the war. The cottonseed industry is one of them. Before the war there was a constant competition between the oil mills for seed. Money was advanced to seed buyers, and the seed, in many instances, was accepted containing large quantities of foreign matter, which had to be taken and paid for or else the mills would shut down.

Since the Food Administration has become very much interested in the value of the products of the cottonseed for supplying this country and our Allies with food and ammunition materials, they have taken the industry under control and established a department of the Food Administration in Washington dealing specially with cottonseed products.

Before the war, if oil mill men got together and decided they could pay a certain price for the seed, they were sent to jail under the anti-trust laws of the various states. If the refiners of the crude oil who made their product into lard compounds got together and attempted to regulate the prices of their products in order that there might be some profit left in the business, they violated the anti-trust laws and were apt to find Canada or some foreign clime far more salubrious than the good old U. S. A. Now all of this is changed. The oil mill men go down to Washington and with the Food Administration agree on a price which they can afford to pay for cottonseed. They also agree with the Food Administration on a suitable price to charge for their oil, meal, and hulls. The Government tells them how much oil, meal, hulls, and linters they should produce per ton of seed. The prices are arranged so that the manufacturer, working with ordinary good management, should make a profit. The agreement is, in a sense, a gentleman's agreement, and there is no law against breaking it, but all the manufacturers are licensed and if they should break the agreements they would lose their licenses. The effect of this arrangement is to stabilize prices and to secure the largest possible production.

The approximate yields per ton of seed are at present:

Oil	41 to 43 gal.
Meal	960 lbs.
Hulls	480 lbs.
Linters	145 lbs.

Before the war 40 or 50 lbs. of linters were considered a reasonably good yield, while the hulls used to be about 600 lbs. per ton.

Although the title "Cotton Oil Industry in War" was selected the words "Vegetable Oil Industry" would have been fully as appropriate, because at the present time cottonseed oil represents approximately only about two-thirds of the oils handled in the plants, which were originally started to crush cottonseed and refine its products.

In 1900 this country crushed 2,480,000 tons of seed, costing $11.55 per ton, and produced products worth $42,412,000. During the crushing season just passed about 4,200,000 tons of seed were handled, for which was paid $65 per ton, and the combined value of the products was in the neighborhood of $400,000,000, or about ten times as great as in 1900.

The cotton oil industry proper gives the country from the seed about 3,200,000 barrels of edible oil, 2,000,000 tons of cake and meal, 1,000,000 tons of hulls used as cattle feed, and 280,000 tons of linters which furnish much of the cellulose for the manufacture of explosives.

In refining the oil there are obtained 192,000 barrels of fatty acids used in the soap industry, and last, but not least, about 3,800,000 lbs. of glycerin used in the manufacture of explosives.

The great muscular activity of the men in the armies and those in the iron and steel and shipbuilding industries calls for a great amount of food which will furnish energy. This is largely supplied by edible fats and oils. Before the war the dairy, the cotton oil industry, and the packing houses furnished a normal

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[1] Presented at the 56th Meeting of the American Chemical Society, Cleveland, September 12, 1918.

supply for this country and exported considerable to Europe. Since the war has started, between short crops of cotton and the big demand for edible fats, materials other than cottonseed oil have been drawn upon to keep up the supply. All told, something like 1,700,000 barrels of vegetable oils were imported during the year either as oil or in the form of oil seeds such as copra, peanuts, sesame, and soy beans. Coconut oil has entered the country largely as copra and much of it has been crushed in cottonseed oil mills. Peanut oil has been imported in large quantities from the Orient and has also been crushed from the peanuts grown in the South and West. The refined oils have gone largely into butter substitutes, some into lard, and some into soap.

Besides furnishing the best edible oils, lard, butter substitutes, cattle feed, cellulose for explosives, soap material, and glycerin to aid the war, the cotton oil industry is furnishing men from its mills, and the places of many of the men are being taken by women.

The Southern Cotton Oil Company
120 Broadway, New York City

THE BUREAU OF FOREIGN AND DOMESTIC COMMERCE ITS RELATIONS TO AMERICAN CHEMICAL INDUSTRY

Papers presented before the New York Section, American Chemical Society, October 11, 1918

GOVERNMENT TRADE-BUILDING INFORMATION

By Chauncey Depew Snow
Assistant Chief, U. S. Bureau of Foreign and Domestic Commerce

In my work in the Bureau of Foreign and Domestic Commerce since the outbreak of the European war I have had more to do with business men connected with the chemical industry than with those connected with any other American industry. Back in 1914 and 1915, when I had just returned from an official visit of observation in Germany, it was dyestuff manufacturers, prospective dyestuff manufacturers, or chemists chiefly interested in dyestuffs, who most frequently came to the Bureau. In the three years following business men connected with every branch of the chemical industry and the chemical equipment industries have had some occasion to deal with the Bureau of Foreign and Domestic Commerce. The detailed analysis of import statistics of dyestuffs which was made for the Bureau and the chemical industry by Dr. Thomas Norton, combined with his reports on atmospheric nitrogen and some minor Bureau contributions on particular sides of the chemical industry, put this government bureau in the minds of a great many men in the industry. The success of the dyestuff census led to the request by your Society for a survey of all chemical imports. Your Society, unlike many of the others, backed its convictions by raising funds to help cover the expense of the inquiry, so the Bureau was glad to pitch right into the work on such a survey. Dr. Pickrell will tell you more about that a little later. Naturally the fact that the Bureau was engaged in this study has had a tendency to interest others of your members in our work and visits to the Bureau by your members have been even more frequent. Not long ago these visits from chemists and others interested in chemicals became so numerous that the Chief of the Bureau remarked it would soon become necessary in our examination requirements for Bureau positions to specify a knowledge of chemistry.

Your committee has requested me to tell here to-night what the Bureau of Foreign and Domestic Commerce has to offer to the American chemical industry. As at present organized the Bureau came into existence in 1912 by Congressional action consolidating the Bureau of Manufactures and the Bureau of Statistics. The Bureau of Manufactures had been charged by law with the duty of fostering, promoting, and developing the manufacturing industries of the United States. The Bureau of Statistics had been charged with collecting and publishing the statistics of imports and exports and tonnage of the United States. Since the consolidation, Congress has laid all the emphasis on trade and the promotion of manufacturing industry by means of promoting trade. The appropriations for the Bureau have been made primarily with a view to enlarging our information about foreign markets. The great bulk of the work during these past six years has been the promotion of the export trade of the United States. The appropriations have related chiefly to the foreign field, and the Bureau has not been given any permanent organization for direct promotion of domestic commerce. In fact, the one little appropriation which we did have for collecting the statistics of the internal commerce of the United States was withdrawn. As matters stand to-day the Bureau of Foreign and Domestic Commerce is the official center of information for all questions pertaining to the movement of goods into the United States from abroad, the movement of goods from the United States to foreign countries, and the movement of goods between the main block of territory of the United States and our non-contiguous territory. Further the Bureau is the chief source of information in this country concerning the trade, industries, and natural resources of foreign countries. We get the information concerning the outward and inward movements of goods in the United States, as most of you know, through the United States customhouses. Declarations of value and quantity are required for statistical purposes in connection with exports, as well as imports. Returns from the customhouses are made to the Bureau of Foreign and Domestic Commerce, which takes care of final compilation and publication of returns. Information concerning the trade, industries, and resources of foreign countries comes through a variety of channels.

The Bureau receives the official statistics, official gazettes, principal trade papers, and other non-official publications, from practically every country and important colony on earth. There is a staff of trained readers, translators, and research statistical clerks working continuously on this incoming stream of printed matter from foreign countries.

Then there is the large number of reports that are constantly coming from the American consular offices which dot the world. Even at this time, when of course we have no consulates in Germany and the other enemy countries, we have over two hundred and fifty active consulates, and one hundred and fifty more consular agencies. A good many of our business men are apt to smile at mention of the consular service, but the really well-informed American business men who have had much contact with the consular service will tell you that it is a remarkably good organization. We need more consuls, and a larger staff in many of the existing consulates. The consuls have a multitude of duties, varying from really responsible representation of the Government to purely notarial functions. They are required to make commercial reports, both with regard to general commercial conditions at the places where they are stationed and with regard to market opportunities for the sale of American goods. The consuls have clearly defined local territories to cover in their reports. Some of our consuls are so pressed with other routine work that they are forced to neglect these commercial matters. Others give perhaps the bulk of their time to commercial matters. During the last couple of years, since our entry into the war, the consuls have had so many additional duties imposed upon them that matters of trade information and trade promotion have of necessity pretty much gone by the board. But the importance of the consular service in our scheme and mechanism of trade promotion and trade information should be recognized and appreciated. For current reports on local matters of importance to American commerce it is to the consuls that we must look.

In addition to the consuls we have, at the principal embassies and legations, officers who are known as commercial attachés. Everybody now knows what military and naval attachés are. Well, the commercial attaché is the accredited representative of the Department of Commerce attached to the staff of the embassy or legation to report on commercial developments of national importance and look out for national commercial interests of the United States. He acts as commercial adviser to the ambassador and at the same time keeps the Department of Commerce, and through the Department the business men of this country, fully informed about developments of general significance to American trade. The commercial attaché is under the Department of Commerce and plays with regard to commerce a part corresponding to that taken by the military and naval attachés with regard to military and naval matters. Unlike the consul, the commercial attaché has as his field an entire country. Unlike the consul, also, the commercial attaché has no other functions beyond those of promoting the commerce of the United States. The commercial attaché is a resident trade representative and exclusively a trade representative.

Another very important part of this mechanism of keeping American business men informed as to the trade and industries of foreign countries is the staff of commercial agents. The commercial agent is a trained specialist in some particular line or phase of commerce who has a distinct assignment to visit certain foreign countries and report on things pertaining to his line of trade or industry which have interest for the American manufacturers and merchants. Thus, when we undertook to make a study of the subject of atmospheric nitrogen in Germany and the Scandinavian countries, we had the investigation made by a chemist of recognized standing and fitness for the work. Similarly, when we had a survey made of South American markets for drug products, patent and proprietary medicines, surgical instruments, and dental supplies, we picked a commercial agent who had had technical experience in connection with those lines. Our study of oils and seed products in foreign countries was made by a man who was known throughout the trade for the work which he had done in that connection. I have taken a few instances relating directly to the chemical industry. In like manner we have had specialists report on foreign markets for agricultural implements and machinery, machine tools, electrical goods, canned goods, cotton and other textiles, boots and shoes, and so on. For some of the more important industries we have had our commercial agents cover practically all countries.

I have described the sources of information of the Bureau of Foreign and Domestic Commerce. I will now touch briefly on the nature of our organization in Washington for handling information and making it available to the business men of the country. In the Washington office, where we have between 150 and 200 workers, we are organized partly on a geographical basis and partly on a subject basis. More interest has been taken in Latin America than in any other foreign field. This is reflected in our appropriations and in our organization. Our Latin American Division is one of the largest and one of the best informed and busiest parts of our organization. It is in charge of a man who has for years specialized on Latin American trade, and is personally familiar with the entire Latin American field. He has a number of assistants who have been in Latin America and the necessary translators and clerical assistants. There is undoubtedly in this Division more trade information with reference to the countries of Latin America than anywhere else in this country, and probably than in any foreign country. This year Congress gave us a special appropriation which made possible the creation of a Far Eastern Division. The Far Eastern Division has been organized, has developed its files, and correlated the available information with reference to the Far East somewhat after the fashion of our Latin American Division. As Russian commercial affairs have loomed so large in the past few years we have developed our Russian information files very largely. In addition to our geographical divisions we have a Division of Foreign Customs Tariffs, which supplies information with regard to tariff rates and customs requirements, consular regulations, and regulations affecting commercial travellers in any foreign country or colony. In this division we also have the information with regard to foreign patent and trade-mark requirements. In the past couple of years our little foreign trade-mark section has done yeoman service in helping American manufacturers to protect their trade-mark rights in foreign countries where German competitors were pirating them under foreign laws by which registration rather than use is the test of validity. We of course have our Division of Statistics, which is the central office for United States trade statistics. Foreign statistics in general are handled by our Division of Research, which also has our information files with reference to foreign countries not covered by specialized divisions. Our Division of Trade Information handles all the non-technical correspondence. We have lists of foreign buyers, classified, for practically every important foreign city. The value of the lists has been lessened, of course, recently by the ever-changing enemy trade prescriptions of the belligerent countries. We have a big collection of trade directories and a list of American manufacturers known to be interested in exporting what we call our Exporters' Index. Incidentally, we have our trade information files very thoroughly indexed and cross-indexed, in order that inquiries may receive the best possible attention. Then we have our Editorial Division, which gets out our daily paper, Commerce Reports, with which many of you are familiar, and the reports of the foreign representatives that I have mentioned. The organization of the Bureau in Washington is for service. The Divisions that I have talked about are arranging the material that comes in from abroad in order to make it helpful to American business men. The Chief of the Bureau's Editorial Division, Mr. Hopkins, will explain to you more in detail some of the aspects and possibilities of that work.

Whereas in former years most of our inquirers were interested exclusively in foreign markets for American manufactured goods, more recently a large percentage of inquirers have been interested in foreign sources of supply for materials to be used in manufacturing in this country. This has been strikingly true as the shortage of ship space has curtailed trade with the more remote parts of the world and has made necessary the use of nearer sources of supply and of new materials that are more readily available with less use of ship tonnage than the customary materials. Our representatives abroad pass on information about new industrial materials, new processes, and new uses of old materials. The Bureau of Foreign and Domestic Commerce is making such information available to manufacturers here.

In short, if there is any phase either of competition from foreign countries in foreign markets or from foreign countries in American markets or any information about needed supplies of old or new raw materials for manufacture in this country, the Bureau of Foreign and Domestic Commerce either has the information or the means and disposition to obtain it.

I have talked at some length and at the risk of going too much into detail in order to make quite plain to you the extent of the trade information and trade promotion service which the Bureau carries on. Questions are sometimes asked as to whether this is all worth while, and both in Congress and elsewhere, occasionally questions are put as to whether there is an actual money return for the funds which are expended in this work. It is hardly a fair test to apply, but the work that the Bureau of Foreign and Domestic Commerce has done will stand even this test. The letters from American firms who have been helped by the Bureau and who have quite spontaneously expressed their gratitude run into thousands. The sales of American merchandise in foreign countries as a direct result of the trade opportunities that are pointed out to American manufacturers by the Bureau have from year to year run well into millions of dollars. There have been instances of single sales that have run up into seven figures. This tangible result is not counted by the Bureau as the main result of its work, however. The Bureau officials believe that they have accomplished more by keeping American manufacturers awake to the importance of foreign trade and of doing it on the best ethical and technical basis than by means of this trade opportunity service. The settling of commercial disputes between traders in the United States and traders abroad has been a line of service carried on by the Bureau which has produced remarkably good results. The good that was done by the American commercial attaché in Australia in the trying years between 1914 and 1917, before we entered the war, can never be calculated in dollars and cents. It was largely through the efforts of this representative of the Department of Commerce that American national good will in commerce was preserved there in spite of vigorous propaganda against the United States and its commercial methods. There is no calculating in dollars and cents the value to American foreign trade in general when individual American concerns are aided by the Bureau to change their export methods so as to conform to the best practice.

We are prone in this country to view our own Government as rendering less assistance to trade than the governments of foreign countries. I am inclined to believe that this is characteristic of business men everywhere. In England for years it has been the practice of business men to knock the Board of Trade, the organization in England which corresponds to our Department of Commerce. In Germany the average manufacturer has always professed to despise government assistance. Here we have pointed to Germany and England as examples of how governments help trade. In England they point to us and to Germany as examples of how government helps trade. In Germany they have pointed to England and to the United States as examples of how government helps trade. So it goes.

When I went to Germany to take part in an investigation of the German pottery industry I went somewhat with the idea that I was going to find government subsidies to trade, which, with starvation wages, had been proclaimed before our Ways and Means Committee as the reason for German success in foreign trade. I made a point of talking with German manufacturers on the subject of the help they received from the government. I never found a manufacturer who would concede that the government was helping him at all—instead he was usually growling at the burden of government taxation and interference. In this very industry that you gentlemen are engaged in in this country there is a disposition to point to Germany and to say that the German government is directly subsidizing the German manufacturing industries and that there is no hope of competing with German manufacturers under these conditions. The tradition that the government was backing all the German trading and manufacturing companies, and that to this was due the success of German industry in the world market, is a dangerous and regrettable thing. There are too many American manufacturers who without knowing the facts are inclined to cry, "Wolf, wolf," and demand government support or government protection on that false basis. In British countries in the course of the liquidation of German concerns there has been a direct effort to trace out the extent of government assistance. To date I have seen nothing as a result of the work of liquidators that has been at all convincing evidence that German success abroad was due to direct government help. In fact, one of the British official liquidators at Hong Kong who made a deliberate attempt to ferret out evidence of government participation in German trade in that colony admitted frankly that the books and papers of the liquidated concerns gave reason rather for the contrary conclusion. We do not know all the facts about the German methods of commercial penetration, and possibly we never shall. We do know that the German government has shown a very sympathetic attitude toward the big commercial interests, has encouraged them in many ways, has given material encouragement to German shipping, and has worked with pretty definite governmental commercial policies, all in the interest of increased national efficiency. Admit all this, however, and yet on the whole we have got to admit further that German commercial and manufacturing success has been chiefly attributable to energy and careful planning in private organization. It will be a bad thing for the American manufacturer to fool himself into abject dependence on government support in getting and holding his business. The American manufacturer in the long run, just like the manufacturer in any other country, must organize better, produce better, and sell better than his competitors. I am not going to enter into any discussion of the merits of government protection and government subsidies, each of which may have its place in carefully organized governmental commercial policy, but I do wish to mention the need of a cultivation of a spirit of self-reliance and confidence in manufacturing and selling ability among the American manufacturers. Our Government can help a manufacturer in a variety of ways. I have to-night pointed out some of the ways in which the Bureau of Foreign and Domestic Commerce can render assistance. I think that in the field covered by the work of the Bureau our Government has done as much and as effective work as any foreign government. Times and circumstances have been greatly changed as a result of the war. Other governments are reorganizing and preparing to spend large sums in promoting their interests in after-war trade. From all that we know of the past and present attitude of our own Government I should say that we have no reason to believe that our Government will not expand its own service, give it variety and new lines of activity, just as much as the national interests require. We must not look to the Government to do the business for us, but at the same time we cannot afford to ignore or underestimate the value of what the Government is prepared to do and is actually doing.

OUR PUBLICATIONS AND THEIR BEARING ON THE CHEMICAL INDUSTRY

By O. P. Hopkins

Chief, Editorial Division, Bureau of Foreign and Domestic Commerce

The recent wonderful development of the chemical industry in this country has awakened in our chemists a desire to be better informed on the relations of the American industry to that of the rest of the world. They have a vision of a permanent and self-contained industry here at home, but they now realize that this vision will never be made a reality by ignoring what is going on in other countries, by making themselves believe that the future is assured no matter what plans, what commercial campaigns, what trade tendencies may be attracting attention elsewhere. They realize, in short, that the time has come for the chemical industry, along with almost every other industry we have, to accustom itself to a much broader view of affairs, to adopt a world point of view.

This has led to the suggestion that the industry is now ready to take a more serious interest than heretofore in foreign-trade statistics and information in general bearing on the exportation and importation of chemicals, raw materials, and machinery and apparatus. The members of this Section will suspect at once that the suggestion comes from Dr. Herty and Dr. Hesse, and such suspicions are well founded. In response to their suggestion I am going to call attention to the wealth of material published by the Bureau of Foreign and Domestic Commerce and offer a few practical suggestions for making use of it.

I suppose the interested members may be divided into two classes: Those who intend to make a practical commercial use of our data, and those who simply wish to keep up with the times, to be well informed on all matters pertaining to their calling, whether or not it will ever mean dollars and cents to them. Both groups will be kept in mind as far as possible.

Our Bureau is the original source of all statistics relating to American foreign trade, and its figures are issued monthly, quarterly, annually, and bi-annually. If a chemist or chemical manufacturer wishes to keep his finger on the pulse of our foreign trade as it rises and falls from month to month, he will turn to the "Monthly Summary;" if he wishes to follow in considerable detail the ebb and flow of imports only, he will study the "Quarterly Statement of Imported Merchandise Entered for Consumption;" if he wishes to review the trade for a whole year as compared with previous years, he will examine the annual "Commerce and Navigation;" and if he wishes to go rather deeply into our trade with any particular country or countries, he will turn to "Trade of the United States with the World," which has been published every two years, but in the future will be published yearly.

MONTHLY STATISTICS

The "Monthly Summary" shows imports and exports by quantities and values for the latest month compared with the corresponding month of the previous year and also for the months of the current fiscal or calendar year ended with that month. For instance, the May number this year gave the trade for May as compared with May of last year, and also the total trade of the eleven months ended with May as contrasted with similar periods in 1917 and 1916. In June the total was shown for the twelve months of the fiscal year contrasted with the two fiscal years immediately preceding, although in much less detail than will be shown in the annual report when it is issued. In July, however, in addition to the statistics for the month, there is shown the total for the seven months of the calendar year, which plan will be followed until the calendar year is finished, when periods of the fiscal year will again be considered.

Countries of origin and destination are shown only for articles moving in great quantities, and this rule unfortunately affects a great many articles in which the chemical manufacturer is interested. Just recently, however, it was decided to show the destination of our rapidly growing dyestuff exports and this feature has attracted considerable attention. Countries are also shown for some of the oils, naval stores, rubber, and the most important metals and ores.

As already stated, these figures enable a manufacturer to keep his finger on the pulse of our foreign trade, but they are just the bald statistical facts. They are not analyzed in any way. Analysis is left to the reader, perhaps to a greater extent than is necessary. At any rate it will be a wise plan for the chemist who wishes to get the most out of the figures to devise some plan of his own for separating out the material in which he is most interested. An outline for a compact little continuous table can easily be made and filled in from month to month, for one article or for some logical group of articles. Percentages of increases or decreases can be shown conspicuously in a number of different ways. Personally, I think a graph is the most satisfactory way of tracing movements of this kind, and it is my understanding that chemists are pretty keen at devising things of that sort.

QUARTERLY STATISTICS OF IMPORTS

The quarterly statistical statement relates only to imported merchandise entered for consumption in the United States. It is designed primarily for Congress and such government officials as may be interested in tariff legislation, for it gives not only the rate of duty for each item imported, but the total amount of duty collected as well. It is not likely that many members of the AMERICAN CHEMICAL SOCIETY are interested in the tariff statistics, but there is one feature of the quarterly statistics that should not be overlooked. The classes are subdivided to a much greater extent than in the "Monthly Summary." For instance, under the heading "Chemicals" in the "Monthly Summary" only two acids are named, oxalic and carbolic, whereas in the Quarterly there are thirty-two. That is an important feature, and one that is very commonly overlooked. The Quarterly, however, does not indicate origin in any case, nor is any comparison made with quarters of previous years. The imports are simply set down in some detail for a quarter of the fiscal year, alongside the preceding quarters of the same year. If it happens to be the first quarter, then no comparison is attempted. If a person decides that he wants to keep his finger on the pulse of the import trade in a certain line of chemicals and finds that there is not adequate information available in the "Monthly Summary," he can turn to the Quarterly and if he wants to go to the trouble of keeping a graph he will soon be able to trace the important developments in his line over a considerable period. For the busy man it ought to be possible to assign the work of keeping the graph or compiling a continuous table to a secretary or clerk. It would take very little time in any event.

ANNUAL STATISTICS BY ARTICLES

The annual "Commerce and Navigation of the United States" is an imposing volume of nearly a thousand large pages of solid statistics. It is so formidable in appearance that many people hesitate to trust themselves to find in it the information they wish, and prefer to write in to the Bureau and have us look up the data. But it really isn't complicated at all. For the chemist, who is accustomed to prying into all sorts of mystifying secrets, this book ought to be a very simple matter. I am sure it has proved simple to any who have tried it.

The three annual tables of prime interest to the chemical industries are No. 3, "Imports of Merchandise," by articles and countries; No. 5, "Exports of Domestic Merchandise," by articles and countries; and No. 9, "Imported Merchandise Entered for Consumption," by articles.

Two features of the tables "Imports of Merchandise" and "Exports of Merchandise" make the volume invaluable to anyone who wishes to make a serious study of our foreign trade. In the first place, all of the countries of origin and countries of destination are given for each article—there are no baffling "other countries" to contend with. In the second place, a comparison is afforded with each of the four years immediately preceding the last. Another feature that deserves mention is the recapitulation under each article showing the imports or exports by continents.

The list of articles in these two annual tables is about the same as that in the "Monthly Summary," but not as detailed as in the Quarterly. Quantities are shown wherever possible, and values in all cases. The tables are used for the most part in making studies of the origin and destination of the goods that enter into our foreign trade. If the chemist wishes to find out where our quebracho imports originate, he turns to the index for the page he wishes and soon comes upon the quantity and value of the imports for each contributing country for the last five years.

The third annual table mentioned as being of interest to the chemist is No. 9, which is an annual compilation of the quarterly statistics already described. It has the same advantageous feature of great detail and the same disadvantages of not furnishing a comparison with preceding periods and of not indicating the origin of the imports. If all the countries of origin were shown for all the articles given and comparisons made with preceding years, this table alone would be larger than the entire volume now devoted to the annual statistics. Possibly the day will come when such a table will be issued, but the demand from many industries will have to be much stronger than it is to-day.

There is also included in this volume a table showing our exports of foreign merchandise, that is, our re-exports of foreign goods. It may occasionally happen that items in that table will interest the chemist. There are twenty-one other tables that need not be described. A good index prevents any confusion that might otherwise result from gathering so many tables under one cover.

STUDIES OF COUNTRIES

The "Commerce and Navigation" is intended to facilitate commodity studies, and is not well suited for studies of countries. If a chemical manufacturer wished to study our trade in caustic soda he would find his information in "Commerce and Navigation;" but if he wished to survey our chemical trade with Argentina, say, he would be almost obliged to turn to our "Trade of the United States with the World," in which each country is taken up separately and its import and export trade with the United States shown in detail by articles.

This work has been published every two years in two volumes, one for imports and one for exports. There is no particular reason why it should not be published every year, and from now on it is going to be.

The statistics are for fiscal years and comparison is made with returns for the year immediately preceding the last.

COMMERCE REPORTS

For the chemist who wishes to have something more than just the statistics of our foreign trade in chemicals there is available the Bureau's daily "Commerce Reports." which relies for its material upon the American consuls, traveling special agents, commercial attachés, trade commissioners, and the experts in the Washington office.

The reports from these various sources cover practically all phases of foreign trade, but for the most part may be said to aim at promoting the sale of American goods in foreign markets. A fair proportion of them bear directly on markets for chemicals and allied materials and products, although there are not as many on heavy chemicals as there will be when the manufacturers of those lines go in for foreign trade on a large scale. When the demand for information increases, the supply will increase. Reports on the markets for such lines as medicinal preparations and pharmaceutical supplies are much more numerous, while on such allied products as paper there is no end of information.

The reports vary widely in character. There may be one on a pressing temporary shortage of caustic soda in Brazil, while another may review at some length the conditions that govern the use of caustic soda in that country, with an opinion as to future developments that will affect the market. Others may throw light on the subject of packing chemicals for certain markets or on tariff regulations.

Sources of raw materials also receive attention and not a few reports are devoted to the appearance of new products in the various countries and to new manufacturing processes.

Actual opportunities for selling goods or forming business connections are featured in a separate department, usually made up as the last page of the paper. Millions of dollars' worth of American goods have been sold through these trade opportunities, and a goodly share has been chemicals or allied products.

But of course this paper appears every day and if a busy man merely glances over it, and perhaps misses a number occasionally, he will not gain more than a very general impression of what is going on in the foreign trade. If he wishes to follow developments more carefully and get practical results, he must devise some way of getting together the material in which he is most interested and keeping it easily available. It is at that point that many manufacturers, chemists among them probably, decide not to see it through.

It happens that I do not know a chemical manufacturer with a working method for extracting the good metal from this mass of ore, but I do know of a system devised by one of our largest hosiery manufacturers. He, the president of the concern himself, spends two or three minutes each morning in marking material in Commerce Reports for filing. His stenographer then clips the marked passages and pastes them on colored paper. White paper is used for reports on hosiery, yellow for reports on miscellaneous wearing apparel, and green for any reports on general conditions that might possibly have a bearing on the demand for hosiery. These are filed by countries and take up very little room. When he wishes to brush up on the hosiery business in Argentina, there is his information right at hand in the most convenient form imaginable. There seems to be no reason why some scheme of this sort would not be just as convenient and valuable for the chemical manufacturer.

However, there is a quarterly index that simplifies matters greatly for those who do not care to establish a file, especially if a set of bound volumes is maintained.

Annual reviews of the trade and commerce of the various countries are printed separately as supplements to Commerce Reports, one for each country. These vary in size according to the commercial importance of the country, but the contents are rather uniform, as the business conditions of the year are reviewed and statistical and other information is given as to domestic production and foreign trade. Special attention is given to the progress American goods make in the market, and the prospects for the future. These reviews are really up-to-date little commercial handbooks and are extremely valuable in reviewing current commercial progress in any country. The chemical trade of course receives its share of attention in countries where it is comparatively important.

SPECIAL REPORTS

The Bureau issues a great many special reports, the majority of which are devoted to the markets for specified lines of goods in specified countries, or districts, although some are devoted to studies of basic economic conditions and some are on unusual but opportune subjects, of which Dr. Norton's reports on the dyestuff situation in this country and the census of dyestuff imports are examples.

The special reports on markets are written by consuls, commercial attachés, and traveling special agents, principally the last named. These traveling agents are specialists in certain lines, such as cotton goods, agricultural machinery, and shoes. Unfortunately, there has never been in the past a sufficient demand from the industry to warrant a special investigation of the foreign markets for American chemicals, but there is such a study on the program for Latin America for the present fiscal year and if sufficient interest is shown in that there will probably be others to follow. The pressure brought to bear on the Bureau for such investigations is the only index it has as to the attitude of the industry.

The catalog of the Bureau's publication will show what special publications of interest to the chemist have been published in the past, and announcements of new reports are printed in Commerce Reports.

SUMMARY

As already pointed out the foreign-trade information published by the Bureau of Foreign and Domestic Commerce can be approached at two different angles by the chemist. He may not be after practical results, as figured in dollars and cents. He may simply wish to keep abreast of the new expansion of the industry in which he is engaged, to know what is going on. A great many people are going to take that sort of interest in foreign trade in the future, just as the average Frenchman or Englishman keeps himself fairly well posted on foreign investment markets, whether he has any money invested abroad or not. We ought to take at least a cultural interest in the great industrial and commercial developments of the country.

But many chemists are going to look at the matter in a very practical manner. To lay a sure foundation for future success they must familiarize themselves with conditions in foreign fields. They must come to look upon business with Argentina, or China, or South Africa, as they now look upon business in the Pittsburgh territory, or the Chicago territory, or the New England territory. It really is not much different when you become accustomed to the longer focus.

The practical minded chemist will also find it necessary to study the facts of our own import trade if he is to make sure progress in his efforts to manufacture here at home the chemicals we formerly purchased abroad. The forthcoming census of imported chemicals is being made to the order of the American chemists.

As the chemists get along in their studies of the Bureau's data they will soon be able to make suggestions for additional service, and I can assure them that the sooner they come the better the Bureau will like it.

THE METHOD OF PREPARATION OF THE CENSUS OF CHEMICAL IMPORTS

By E. R. Pickrell
Special Agent, Bureau of Foreign and Domestic Commerce

It was with pleasure that I accepted the invitation of Dr. Herty to state briefly for your information the method of preparation of the Census of Chemical Imports. As you gentlemen well know, the idea of this census was conceived by your fellow member, Dr. B. C. Hesse. Upon request of representatives of the American Chemical Society, the Department of Commerce undertook for the benefit of American chemical manufacturers this monumental statistical work. The Census of Dyestuffs which was published in 1916 by the Bureau of Foreign and Domestic Commerce was the initial undertaking of this kind by any branch of the United States Government. How well Dr. Norton accomplished this vital and timely task is shown by the fact that requests for copies of the dyestuff census have been received even from foreign countries. To-day the domestic dyestuff manufacturers have at their disposal information concerning the importation of dyestuffs into the United States which is of inestimable value for the development of a permanent domestic dyestuff industry.

The Census of Chemical Imports is a much greater and more difficult task than the dyestuff census, for it entails the procurement of information relating to a vast and varied number of articles. The statistical data presented by this census will be of value not only to chemical manufacturers but also to the drug manufacturers, synthetic medicinal manufacturers, perfumery manufacturers, paint and varnish industries, oil industries, and fertilizer industries.

During the fiscal year 1913–1914, chemicals, allied chemicals, drugs, and medicinals imported into this country totaled in value $176,000,000. This total was divided as follows:

Chemicals, drugs, dyes, and medicines	$95,000,000
Oils	46,000,000
Fertilizers	23,000,000
Tanning materials	2,000,000
Perfumes	2,000,000
Paints	2,000,000
Glue	2,000,000
Grease and oils	1,000,000
Soap	1,000,000
Oleostearin, dyewoods, beeswax, and blood (each)	500,000

Inasmuch as the object of the Census of Chemical Imports was to show the quantity, value, country of origin, and per cent of the quantity imported from each foreign country of every chemical, drug, allied chemical, and medicinal imported into this country for the fiscal year 1913–1914, the last normal year, and since there was no available statistical data in this country setting forth this information, it was necessary to examine every invoice filed at the different customhouses in this country during that one fiscal year.

In view of the fact that more than sixty per cent of all the articles imported into the United States come through the Port of New York and that probably seventy-five per cent of all the chemicals imported are entered here, it was deemed advisable that the clerical staff engaged on the census personally examine the New York entries.

The original request was made to the Secretary of the Treasury that all invoices, some 700,000, received in the United States for the fiscal year 1913–1914 be forwarded to the Port of New York for examination by the staff engaged on the census. That official was of the opinion this procedure would not be advisable because of the increased liability that some of these very valuable records might be lost or destroyed in transit. The alternative procedure was then adopted of sending circular letters of instruction, with an appended alphabetical list of 3500 chemicals, allied chemicals, drugs, and medicinals to the collectors of the headquarters ports of the forty-eight customs districts into which the United States and its territorial possessions are divided, requesting that invoices covering all these articles be forwarded to New York.

It is the aim of the census to amplify Schedule E of Imports, that is, Table 9 of the Commerce and Navigation Reports published by the Bureau of Foreign and Domestic Commerce, maintaining the same classification as closely as possible, but always keeping in mind that the purpose of the census is purely commercial. Consequently the commercial classification has had precedence over scientific terminology. It would have been a much easier task to have devised and employed a strict scientific classification and disregarded entirely Table 9, which follows more or less closely the Tariff Act of October 3, 1913.

This amplification is to show the quantity, value, and per cent imported from a foreign country of every chemical, allied chemical, drug and medicinal imported into this country during the fiscal year prior to the European war. In other words, the seventy-five classes covering these articles provided for in basket clauses in Table 9 are to be amplified into over three thousand articles. By means of this amplification each article will be specifically designated instead of being grouped together, as formerly, in general terms or basket clauses. For example, Table 9 now provides for 32 acids by name. The Census of Chemical Imports will show more than 60 acids by name. Every acid imported into this country in the fiscal year 1913–1914 will be provided for in the census. This same table lists 21 soda compounds. The census has already more than 52. There are an unlimited number of articles, many of which are of common chemical usage which will be provided for definitely in the census and which are at present hopelessly lost in the basket clauses. Table 9 does not show more than half a dozen synthetic medicinals; the census will show every synthetic medicinal imported during that year. Whereas in Table 9 medicinal compounds, preparations, and salts to a value in excess of $315,000 were grouped together in one general class, the census will completely subdivide this class so that probably more than 150 different medicinal preparations will be shown. Then again, crude drugs valued at over $1,000,000 were imported during the fiscal year 1913–1914. These drugs, which were divided into two general classes in Table 9, will be completely separated into over 250 different articles.

To gather this tremendous amount of detailed information a staff of 24 clerks has been employed, some since March 1918, in translating and transcribing the necessary information from more than 35,000 invoices gathered from every customs district in the Union.

For every single article mentioned in each entry an individual card was made, stating thereon the country of origin, the quantity and value, and the English name as translated from the foreign language. More than 90,000 such cards were made out. These 90,000 cards were then assembled into groups containing the same articles, and the quantities and values, according to country of origin, were totaled. This information was then transcribed to larger cards and the foreign monetary and quantitative terms converted into American dollars and units of weight. The quantities from the various countries of exportation were ascertained and expressed in percentages employing the entire quantity imported as the equivalent of one hundred per cent. The following are examples of the information to be presented in the census and the manner of presentation:

	Value	Quantity Lbs.	Country of Origin	Per cent
Titanium Potassium Oxalate....	$839	4,859	Germany	53.9
			England	46.1
Carbon Tetrachloride..........	$32,616	657,409	Germany	97.9
			Italy	1.9
			Canada	0.2
Tartaric Acid................	$218,856	906,614	Germany	39.1
			England	19.8
			Italy	17.1
			Austria	9.1
			Netherlands	7.8
			France	7.1

The mass of statistical data collected was so great it was deemed advisable to incorporate in the body of the census only those articles having a total value in excess of $100. At present there are over 3,000 articles having a value of over $100, as compared with 75 classes now provided for in Table 9. The number of articles is steadily increasing and will approximate about 4,000. Those articles having a total value less than $100 will be listed alphabetically as an appendix to the census. The grand total value of all these articles less than $100 will be shown in the census.

It is hoped that this Census of Chemical Imports will clearly present to domestic manufacturers of chemicals, allied chemicals, drugs, and medicinals what they may expect in the way of foreign competition when this world conflict is over; that this information will be in such detail and so definite that American production of these commodities will be stimulated; that every American manufacturer dependent upon these commodities will be able to obtain them as a result of American production; and that an American chemical industry brought into existence through extraordinary circumstances will remain and grow to be one of the bulwarks of American industrial progress and development.

Would it not be advisable to present to the American manufacturers in a series of half a dozen well-stated publications, covering the chief classes of materials provided for in the census, such as coarse chemicals, paints, perfumes, oils, fertilizers, and synthetic medicinals, the information contained in the census relating to these articles, the quantities and values of the same imported during the year 1917–1918, and the quantities and values produced and consumed in the United States during the same year, so that each manufacturer of a particular class of articles will be cognizant to a minute degree of all factors affecting his trade?

CURRENT INDUSTRIAL NEWS

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

ANALYSIS OF WHITE METAL

As rapid analyses of white metal are frequently made, the following note on the subject, which appeared in the *Z. angew. Chem.*, for April 30, may be of interest. About 1 g. of the metal borings is dissolved in 10 cc. nitric acid, density 1.4, the solution being diluted with 50 or 100 cc. hot water, boiled for 5 min., and then filtered. The moist precipitate (consisting of oxides of tin and antimony) is washed into a conical flask, heated and diluted with water; about 2 g. of pure powdered iron are then dropped into the flask and the liquid is kept at 80° C. for about 1 hr., air being excluded. The tin will have dissolved as stannous chloride, which is estimated by ferric chloride, while the antimony is precipitated as metal on the excess of the iron which is extracted with hydrochloric acid. The original filtrate contains the lead, copper, iron, and zinc of the white metal. Sulfuric acid is added to the solution which is evaporated to dryness and redissolved in water. The lead remains insoluble as sulfate and the other metals pass into solution. The copper is precipitated by sulfureted hydrogen; the iron is oxidized by bromine water and precipitated as hydrate by caustic soda. The zinc is finally precipitated from the filtrate, previously made acid with hydrochloric acid, by soda.

LUBRICATING OIL

Oil of a quality suitable for aeroplane motors is being obtained in Russia largely from hempseed. The presses produce a yield of from 5 to 6 per cent of a dark gray colored oil. Refining and filtering processes give as a pure lubricating product, 30 per cent of a clear yellow oil. The crude residue is used for soap making. As the manufacture has been carried on mainly by Austrian prisoners of war, the processes will soon be made known in Austria and Germany where, consequently, large quantities of seed are already available.

VENEZUELAN TRADE INQUIRIES

The British Consul at Caracas reports that a firm of commission agents in that city desires to represent in Venezuela, firms dealing in drugs and medicines, hardware, etc., also that a firm at Barquisimets would be glad to get into touch with firms interested in importing castor-oil beans. These latter have recently, in not inconsiderable quantities, been shipped to the United States, and in view of the good market obtained, this plant, previously regarded as a weed, is now being assiduously cultivated in Venezuela. The oil furnished by these beans is said to be the only one which satisfies all the requirements for lubricating aeroplane engines.

POTASH SALTS IN CHILE

The existence of nitrate of potassium as a by-product of the nitrate of sodium industry has been engaging the attention of chemists and mining engineers in Chile for some time past. According to the *Canadian Weekly Bulletin*, one of the best known scientists in Chile claims to have discovered a process for its extraction by refrigeration and is proving the efficiency of the process by practical application. From his investigations he has ascertained that potash exists in all the nitrate regions, being most plentiful in the Tarapaca region, followed by Taltal, Antofagasta and Tocopilla in rotation of importance. Out of 165 oficinas, there are at least 100 whose caliches contain 1 to 2 per cent of potassium nitrate. He estimates that in the residues of the saltpeter industry, 600,000 tons of potash are thrown away yearly. Analyses made of saltpeter ready for shipment proved the existence in this of 0.7 to 3.6 per cent. If an average of 1 per cent be taken out of 3,000,000 tons of sodium nitrate exported, there are 30,000 tons of potassium nitrate given away. Of the 600,000 tons thrown away in the residues of the oficinas supposing that only 60 per cent is utilized, there remain for exportation 360,000 tons.

NEW CONCRETE MIXER

A machine recently brought out by Messrs. Winget, 25 Victoria St., London, says the *Times Trade Supplement*, is designed particularly for the efficient mixing of semi-wet concrete, though it is also adapted to the mixing of concrete of any consistency to the other extreme of wetness. It consists of six patent chain paddles rotating at 35 r. p. m. in a semi-circular trough. Paddles of this form, it is stated, increase the mixing by more than 100 per cent as compared with the solid spades previously used, and also present the advantage that no stone can wedge between them and the trough so that aggregate of any shape or description can be used. The cement and aggregate are fed into a hopper above the trough into which they are discharged by the depression of a lever, and water is added at any stage in any quantity by turning a tap in an overhead pipe, which insures even distribution. The mixed concrete is finally discharged by pulling a second hand lever, which rotates the trough on its trunnions. At present the machine is being made in one size only, with a capacity of 3 cu. ft. Through this 60 completely mixed charges can be passed in an hour, equivalent to 67 cu. yds. per working day of 10 hrs. The machine, which weighs 1$^1/_4$ tons complete, is driven by a 2$^1/_2$ h. p. paraffin engine. A larger size with a capacity of $^1/_2$ cu. yd. is now being tested and will, it is expected, be ready for commercial manufacture shortly; its weight complete is about 3 tons and it is driven by an 8 h. p. paraffin engine, which is arranged through a friction clutch also to rotate the trough on its trunnions for discharge.

COMBUSTION OF COAL

It has been shown by experiment, says the *Engineer*, that the sulfur contained in coal in the form of pyrites is not the chief source of spontaneous combustion, as was formerly supposed, but the oxidation of the sulfur in the coal may assist in breaking up the lumps of coal and thus may increase the amount of fine coal which is particularly liable to rapid oxidation. Even this opinion is not unanimously endorsed. In spite of experimental data showing that sulfur is not the determining element in spontaneous combustion, the opinion is widespread that, if possible, it is well for storage purposes to choose a coal with a low sulfur content.

BATIK DYEING PROCESS

A special display of textiles dyed by the Batik process was exhibited at the Leipsic Spring Fair this year and in a statement issued by the *Textil Zeitung* information was given that the use of the process was spreading rapidly among manufacturers and was likely to become a great and important branch of the textile industry after the war. "Batiking" is well known to United Kingdom manufacturers and United Kingdom firms were the first to offer to the Straits Settlements, where it was originally introduced from Java and is exceedingly popular, goods dyed either by the same or a modified batik process. The *Textil Zeitung* claims that the process has been amplified and perfected in Germany during the war. Certain tissues, which hitherto would not take certain colors, can now be dyed. Stuffs, blouses, stockings, hats, etc., can be redyed by it when they are old and can take a lighter color or be entirely changed. It has been possible to use apparently useless or faded goods. The following account of the batik process written by an authority in the Netherlands East Indies is of interest: To batik signifies to cover a cotton fabric with a thin ground of wax before plunging it into a bath of dye so as to preserve from the latter certain parts of the stuff thus forming a design. This operation, repeated several times in succession but with a dye of different color on each occasion, and with the stuff recoated so as to preserve different portions from the dye, finally produces a design which is often of real artistic value.

LAMP TESTS

In the *Schweizerische Elektrotechnische Zeitschrift*, for January 5 last, is given a summary of the results obtained from tests of various lamps with the orthochromatic plates and silver eosin plates prepared by two German firms. The tables show wattage and candle power of various lamps and their actinic value, absolute and per watt and per Hefner candle power for both kinds of plates with and without yellow filters. The lamps tested in this way were the Hefner lamps, vacuum and gas filled, tungsten-wire lamps, arc lamps with solid carbons and yellow and white-flame carbons, enclosed arcs and quartz-enclosed mercury arcs.

NEW RADIOACTIVE ELEMENT

The *Chem. Trade Journal*, 62 (1918), 512, quoting from the *Münchener Newste Nachrichten*, says that after a number of unsuccessful attempts by several scientists to discover the mother substance of actinium, recent efforts have succeeded not only in isolating this substance but also a new radioactive element of great emissive power. L. Meitner states that the material taken as a starting point for the investigation was the residue, insoluble in saltpeter and acids of pitchblende, which forms the raw product of radium. This residue was subjected to treatment which finally left undissolved only the substance of the tantalum group, and this final residue showed a radiation, at first weak but afterwards increasing greatly though gradually, which mainly proceeds from the evolution of actinium, showing that the element contains actinium and must, indeed, be its mother substance. The new element has been named Protactinium. Its period of semi-integration, *i. e.*, length of time which elapses before half the atoms are separated from one another, probably fluctuates between 1,200 and 18,000 yrs. The production of protactinium requires large quantities of raw material; for about 1 kilo of the pitchblende residue insoluble in saltpeter and acids 73 milligrams of protactinium are obtained. The substance is obtained in the form of a white powder which contains the new element at first only in very small proportions and with a large admixture of earthy acids. Experiments for the separation of the element from the acids will be undertaken immediately.

RUBBER-SEED OIL

The report of the Federated Malay States Agricultural Department shows evidence of the growing tendency to apply scientific methods to the rubber industry. A description is given of the method of manufacture of rubber-seed oil and its residual product with a view to putting it on a commercial basis. It would seem, from the report, that this high-grade oil requires hardly any refining, is obtained from a waste product available in great quantity, easy to collect, transport and store and easy to crush. It would certainly pay in normal times to ship the seeds or kernels but, as the prospects of freight facilities for some years do not present a bright outlook, it would seem that shipping the oil is the better proposal. Oil keeps better than seeds and is more easily stored. Experiments with a consignment of 30 tons of seeds sent to England resulted in $250 per ton being obtained for the oil, while $40 per ton was realized for the residual cake. At the time linseed oil stood at $300 per ton. The difference of $50 per ton may be put down to the prejudice with which all new products have to contend. As far as can be foreseen, rubber-seed oil will occupy a place but little inferior to linseed oil as soon as the world's markets have acquired confidence in the new product. Finally, the production of rubber-seed oil would not interfere with the market for coconut oil or sesame, as these oils are used essentially as human foods in the form of margarine and cooking fats. These oils are never used (as rubber-seed oil is likely to be) for paints, varnishes, red and white lead, packing compositions for joints, soft soap manufacture and the like.

THE SCHOOP METAL-SPRAY PROCESS

According to a note by K. Matzinger in the *Anzeiger für Elecktroteknik und Maschinen-Bau*, April 28, 1918, by increasing the "atomizing pressure" in the pistol of the Schoop apparatus, metal deposits of very fine grain and high density and strength have recently been obtained. The pistol is a blowpipe in which the metallic bead, fused by the flame, is torn away and atomized by the current of compressed air. The ordinary working pressure of the air is 3.5 atmospheres, but the pistol operates on the injector principle and the actual atomizing pressure was so far only 1.5 atmospheres. This pressure has recently been raised to 2.5 and 3 atmospheres without increasing the working pressure, with very promising results. A lead pipe, 1 mm. wall thickness, made by the improved process, was filled with hydrogen at 5 atmospheric pressure while lying in water; no hydrogen escaped while hydrogen bubbles forced their way through a lead pipe made by the old process. In another experiment plates of sheet iron were covered with lead, one or two coatings at pressures of 1.5 or 2.5 atmospheres. The one or two coatings of the old process did not prevent subsequent rustings of the iron, but both the one coating and the two coatings of lead deposited at the higher pressure kept the plates free from rust when they were placed in water.

CATALYTIC PROCESSES IN GERMANY

The Badische Anilin Company is developing some promising catalytic processes, says the *Gas World*. When a mixture of two volumes of carbon monoxide and one volume of hydrogen is passed over asbestos impregnated with cobalt or osmium oxide and some caustic soda, at temperatures from 300° to 420° C. and pressures from 100 to 120 atmospheres, the result is the production of water, carbonic acid, methane, higher hydrocarbons and oxygenated compounds such as aldehydes. The hydrocarbons are saturated and unsaturated with a boiling point above 250° C. If carbon dioxide is used instead of carbon monoxide, the yield of hydrocarbons is reduced. By adding nitrogenous or sulfur-containing components to the gas mixture employed, nitrogenous or sulfur-containing organic compounds are produced by the catalyzers. Catalyzers of higher heat conductivity, such as rods or wires of metals or carbides, especially those of the iron group, tend to prevent the reaction from hanging back.

CADMIUM IN BRASS

As much of the zinc now imported into France contains considerable proportions of cadmium, Léon Guillet (*Comptes rendus*, March 6, 1918) has investigated the influence of cadmium on the mechanical properties of brass. He prepared alloys containing 70 to 60 per cent copper, 28 to 40 per cent zinc, and up to 4.54 per cent cadmium. The high percentage of cadmium is accompanied by a relatively high percentage of lead to which Guillet does not draw attention. The other impurities were iron and tin, neither present in more quantity than 0.1 per cent. He found that cadmium had little influence on the properties of the brass, as long as cadmium did not exceed 1 per cent, and higher percentages are fortunately rare. The influence of cadmium was distinctly deleterious. It lowered the hardness and general strength and this was particularly noticeable in the impact tests which were made on notched bars. The elongation was hardly affected as long as the cadmium remained below 2 per cent. For low percentages the cadmium could be traced in fine lines surrounding the grains of alloy; when the percentage went higher the cadmium was seen to be isolated in round grains. It would appear that the cadmium enters into solid solution when present in small proportions. The detrimental effects of the presence of cadmium were more striking in an α than in an α-β brass.

ACID RESISTING FERROSILICONS

The publication by Camille Matignon in *Comptes Rendus* of May 21, 1918, of the results of corrosion tests of his comes somewhat late. He conducted tests in 1913 with the alloys then obtainable and the analyses and corrosion values are interesting. His alloys contained between 13 and 17 per cent silicon, nearly 1 per cent manganese and in addition to the usual phosphorus and sulfur only the constituents we mentioned. The métillure of Adolphe Zouve contained 2.5 per cent aluminum; one of the two elianites (an Italian product) contained 2.2 per cent of nickel and seemed to be less corrodible, owing to this constituent; the other ferrosilicons were ironac and duriron. Matignon further tested a ferroboron containing 70 per cent iron, 15.4 per cent boron, 4.9 per cent silicon, and 3.3 per cent manganese; and Borcher's metal, a nickel chromium alloy containing 64.6 per cent nickel, 32.3 per cent chromium, 0.5 per cent silver, 1.8 per cent molybdenum. The corrosion tests were made in boiling nitric acid and in boiling acetic acid and butyric acids, concentrated and diluted. The ferroboron was easily attacked; the Borcher's metal differed from the other alloys by resisting diluted acids better than concentrated acids, but was not otherwise superior to them. The best métillure was a very homogeneous alloy. None of the alloys resisted hydrochloric acid, and there is no mention of sulfuric acid. Some of the tests were continued for a period of 360 hrs.

NEW NORWEGIAN INDUSTRIES

A recent exhibition in Christiania illustrating Norwegian industrial self-help shows that an extensive work has been undertaken to make Norway more independent of foreign supplies. A factory for the making of crucibles based on artificial graphite from the Arendal Smelting Company will soon commence operations at Langesund. Ferromanganese was formerly imported, but is now made at the Fiskaa Works, several concerns having taken up the manufacture of electrodes, of which 8,000 tons were formerly imported per annum. The requisite quantity of sulfate of aluminum, some 400 tons per year, is now being made within the country. Chloride of lime, soda lye, glue and various dyestuffs, red lead, etc., will be manufactured on a basis which will leave some for export, after the country's requirements have been met. Iodine, which formerly it did not pay to manufacture on account of the powerful Iodine Trust which the war has broken, will now be made on a scale large enough to supply all Scandinavia. A Holmestrand concern has worked out new methods for the preparation of bismuth and various preparations from it. Nitrocellulose and collodion cotton are now being made from ordinary cellulose, which seems to yield a suitable product. Formerly Norway imported her entire requirements of grinding materials, especially from America, Germany, and Austria, but now these are being entirely covered by home manufactures. The exhibition also comprised electric lamps, porcelain articles for electro-technical purposes, and material for the complete equipment of electric installations, electric cables, etc.

NEWFOUNDLAND COD-LIVER OIL

The Imperial Institute, London, is calling the attention of importers to Newfoundland cod-liver oil. Hitherto the bulk of the refined medicinal cod-liver oil used in the Empire has been of foreign origin, Newfoundland having devoted attention chiefly to the production of industrial cod-liver oil for currying leather. The oldest British colony has, however, now taken its cod-liver oil industry seriously in hand and is in a position to provide not only the industrial oil, for which it is famous, but also refined oil equal in quality to the finest medicinal oil produced in Norway. The Imperial Institute is prepared to supply analyses of Newfoundland oil, names of exporters and other information on the subject to importers interested in this branch of trade.

NATIONAL METAL AND CHEMICAL BANK

The directors of the National Metal and Chemical Bank have issued a circular, says the *Chemical Trade Journal*, detailing the objects of the bank. For the purpose of its business, it is to assist "in the coördination of British interests in the base metal, chemical and allied industries." It has already acquired extensive interests in undertakings producing iron ore, coal and the principal nonferrous metals and, through its associated concerns, is in a position to arrange for the smelting and refining of gold, silver, lead, bullion, lead ore, zinc ore, etc., and to supply all descriptions of manufactured lead, zinc and alloys. The bank is also largely interested in chemical undertakings, producing dyes of all kinds, sulfuric acid in large quantities, and in superphosphate works in course of construction.

DISCOLORATION OF WHITE PAINT

Zinc-white enamels frequently turn yellow and brown, especially in warm atmospheres both in the light and dark. In some cases this discoloration is merely a staining of the paint with atmospheric dust and dirt. In others it is not without reason attributed to the presence in the pigment or oil of traces of lead. Dr. D. F. Twiss discussed the question in the *Journal of Chemical Industry*, June 29, 1918, and found that lead cannot in all cases be responsible, since the discoloration sometimes proceeds in the absence of all sulfureted hydrogen and is not accelerated by its presence. The linseed oil and varnish themselves tend to turn brown when absorbed by dry filter paper and kept for a few hours at 60° C., and the brown color appeared quite as readily when this experiment was performed in sealed tubes, charged with pure carbon dioxide as under ordinary conditions; thus the presence of oxygen and the action of high temperature which would polymerize the oil, are not at all essential, contrary to expectation. On the other hand, it proved possible to bleach the brown tint again by the light rays from a quartz-mercury lamp. For this reaction the presence of oxygen is necessary as was expected, the real bleaching agent being the ozone. Dr. Twiss was able to repeat the discoloration and bleaching experiments several times with the same specimens. The effects might also be due to the presence of manganese or of alkalies, but the experiment in carbon dioxide is against the latter assumption and, even if radioactivity should be concerned in the phenomena, which is not unlikely, the color change would ultimately be the manifestation of a chemical change in the pigment or medium.

GAS IN GLASS INDUSTRY

At the annual meeting of the Society of Chemical Industry, Dr. Morris Travers gave an account of the establishment of one of the three large British glass works which have been brought into existence since the war began. Dr. Travers said that in the early experiments at one factory oil-fired furnaces were used, but eventually it was decided to put down a gas-fired furnace which was built and running in seven weeks and was capable of turning out 5 tons of glass per week. This was a non-recuperative furnace, but a later one was recuperative. The greater control and quicker working which gas gave opened up the prospect of knocking off the night shift which was now necessary in this industry. Discussing the requirement in regard to chemical glass, Dr. Travers commented on the fact that every chemist wanted an infinite range of beakers. That meant that blowing machines could harly be used in the industry because the large variety meant that only a comparatively few of each could be made. If it were possible, as he believed it was, to have beakers in three sizes only, between the liter and 50 cc., instead of eight, blowing machines could be introduced which would considerably reduce the cost of manufacture.

HEATING IN A LIQUID

There has been prepared by Messrs. J. Wright & Company, Birmingham, says the *Gas Journal*, a useful booklet on the "Use of liquids, consisting of fused salts or mixtures of salts for the heating, quenching and tempering of carbon steel and high speed steel." Attention is drawn to the advantages of heating in a liquid and there are brief descriptions of various kinds of melts that have been evolved for different purposes. There are numerous difficulties encountered in the use of a lead bath for heating, and these are pointed out. Barium chloride is used for heating high-speed steel and "Pyromelt" for carbon steel or carbonized work. The latter is so light that the trouble experienced in the case of lead of articles floating on the surface does not arise. Then there is "Feusalt" for quenching high-speed steel, for tempering and for heat treatment; "Tempermelt" for tempering and for heat treatment; and patent "Quenchoid" for tempering carbon steel and for heat treatment. The booklet also contains illustrations of Wright-Brayshaw furnaces for the various salts, and the final page is devoted to a comparison of the Centigrade and Fahrenheit scales. Copies of the booklet may be had on application to the firm.

SOURCES OF ORE

According to *Metall und Erz*, new sources of mineral wealth are to be found in European Turkey. Copper ore exists in great quantity in Turkish Rhodope in the neighborhood of Yardimli. In the Turkish Balkans, ores of nearly all the metals occur, while gold is found in Markova Reka, south of Uskub. In the neighborhood of Kratova, gold, and galena, containing a fairly high percentage of gold, have been found. Chromium ore in abundance has been discovered near Niausta on the Salonika-Monastin railway. The mountain range of Southern Macedonia is especially rich in chromium ore and there are also ores of iron, antimony and lead.

BOLIVIAN WOLFRAM INDUSTRY

According to the latest available figures, nearly 25 per cent of the output of wolfram in Bolivia is enemy-controlled. The total production in 1916 compiled from figures giving the output of the mines was: in non-enemy mines, 2,388 metric tons, of which 1,364 tons were sent to the United States and 1,360 to the United Kingdom; in mines belonging to the enemy, 658 tons were consigned to the United States.

GAS AND PETROL ENGINES

A series of vertical gas and petrol engines are described and illustrated in a catalog sent by the Keighley Gas and Oil Engine Company, of Keighley. They are made with one, two, or four cylinders, and while the one- and two-cylinder types are arranged for thermo-siphon cooling with radiator, water circulation is employed in the four-cylinder type, a centrifugal pump being driven from the cam shaft, as is the magneto, by a silent chain. In the two- and four-cylinder engines oil is forced under pressure to all the bearings by means of a geared pump driven from the cam shaft by skew gears, while in those with a single cylinder a pump of the plunger type is employed. A centrifugal governor, totally enclosed with all its connections inside the crank case, is coupled direct to the throttle value in the carbureter and varies the mixture to suit the load. A number of self-contained electric generating sets, with the engine, dynamo and all accessories mounted on a cast iron base plate, are illustrated in the catalog, which also describes similar self-contained air compressor and pumping sets, together with stationary, semi-portable and portable engines for farm and estate duty.

ANTIFRICTION METALS

A French report on new antifriction metals includes trials of alloys consisting chiefly of aluminum, cadmium, magnesium, and especially of zinc. Such alloys were designed to reduce as far as possible the use of copper, tin, lead, and antimony, and the most satisfactory results are stated to have been given by a compound of 63.3 per cent zinc, 21.3 per cent tin, 12 per cent lead, and 3.3 per cent copper.

HYDROSULFITES

At a meeting at King's College, London, Mr. F. Rogers said that the value of hydrosulfites in their application to industry seems to have been fully recognized by German chemists and that much labor had been expended in the problem of solidifying them. French and American chemists had also worked at the problems with the result that they were now obtainable in a stable form. Sodium hydrosulfite is extremely valuable as a reducing agent, one of its principal uses as such being in dyeing with indigo. It is also used for clarifying sugar, molasses, edible oils, soaps, etc. It is a valuable straw bleacher and is prepared in a convenient form for the removal of stains. Up to the present time, English chemists have never taken sufficient interest in the compound but now it can be obtained in large quantities, thus enabling industries to be carried on, which otherwise would have been crippled.

METALLIC LIQUIDS

A pamphlet received from Messrs. George Lillington & Co., of 40 Holburn Viaduct, E. C. 1., describes their "Metalo" liquid which in various forms is used for hardening concrete and cement, for waterproofing and hardening external and internal walls, roofs and old work, for waterproofing wood and preserving it from rot, decay and vermin, for hardening wood and plaster and rendering them waterproof and fire-resisting, and for preserving iron and steel work. Some tests are quoted showing the effect of the liquid, which is merely added to the water used in mixing, on the strength of concrete. Briquettes made of three parts of sand to one of cement, which gave under pulling tests 275 lb. per sq. in. after 14 days, and 345 lb. per sq. in. after 28 days, gave 316 lb. per sq. in. after 14 days and 388 lb. per sq. in. after 28 days when a 1 to 5 solution was employed. A 6-in. cube of concrete, containing three parts of aggregate to one of cement, together with 5 per cent of the liquid, had a crushing strength of 43.6 tons at the end of 28 days, whereas the crushing strength of a similar cube not treated with the liquid was only 33 tons after the same time.

STARTING RHEOSTATS

A list received from the British Thomson-Houston Company, of Rugby, describes two forms of starting rheostats for electric motors, in both of which the switch and resistance are enclosed in such a manner as to prevent access of dust and give complete protection to all live parts. In one form, intended for use with motors from 0.25 to 7.5 h. p., the contact brush is of the skate type, pressed on the contacts by means of a steel spring, and the starting period allowed is 30 seconds with normal full current. In the other form for motors of 3 to 40 h. p. the contact brush is made up of a carbon portion, which reduces sparking to a minimum, and of a brass portion which carries practically all the current; a starting period of 40 seconds is allowed. These rheostats comply with the Home Office Rules for the use of electricity in factories, and with the British Engineering Standard's Association's specification for normal duty rheostats. They can be used for starting and stopping motors as often as four times an hour, though this starting duty does not represent the limit since the resistance units are constructed to withstand excessive temperatures without damage.

AIR RAID SIGNALS

Engineering publishes some interesting particulars of the Challot rotating vanes and the series of horns forming the sirens now mounted on monuments in numerous French towns to give warning of the approach of hostile air craft. The siren consists of a casing or stator within which an aluminum rotor revolves on ball bearings. The stator and rotor each have a number of openings generally rectangular. Vanes for canalizing the air start from the center of the rotor and end at the rotor openings. When the rotor revolves centrifugal force drives the air through the openings and the flow is alternately permitted or interrupted according as the openings in rotor and stator coincide or not. The rotor is driven by an electric motor of 12 to 15 h. p. Conical horns of suitable shape and length are connected to each opening of the stator in order to amplify the sound. The Paris sirens have a total weight of 1,700 lbs. and in the city cannot be heard beyond a radius of 1.5 km. (under 1 mile), although in the open the range may be as high as 8 to 10 km. Hand-operated sirens have also been built for giving the alarm in small towns.

OXIDATION OF AMMONIA

At the British Scientific Products Exhibition held in London during August, a unit plant for the oxidation of ammonia to oxides of nitrogen was exhibited. Such a plant was not extensively used outside Germany before the war and there is reason to believe that the Germans have relied on it very largely for their output of nitric acid for explosives, as well as in the manufacture of sulfuric acid by the chamber process. The method is now in use in this country and several large firms such as Brunner, Mond and Company and the United Alkali Company are using apparatus similar to the plant shown at the Exhibition.

SYNTHETIC RUBBER

At a recent meeting of the German Bunsen Society held at Berlin, the question of synthetic rubber was discussed and its possibilities as a substitute for the natural product were considered. The world's requirements before the war amounted annually to some 145,000 tons. Since 1914, however, the demand apart from the needs of the Central Powers has increased to 220,000 tons. Of this quantity America takes the greater part. In the period 1910–12, according to the *Chem. Trade Journal*, 63 (1918), 162, attempts were made by Frantz Hoffman at Leverkusen to produce a substitute by synthetic processes. These were in large measure successful but the constant fall in prices of the natural product resulted in the partial abandonment of the experiments. The enormous demand brought about by war conditions and the shortage in Germany and Austria have given fresh impulse to this promising new branch of industry. In spite of the difficulty of obtaining materials 150,000 kilos of methyl rubber are produced monthly. It was not at first a wholly satisfactory substitute, for it became oxidized in air and was somewhat refractory in the process of vulcanization. These objectionable qualities have, however, been in large part removed by improvements in manufacture. By the addition of other substitutes a useful hard rubber, it is said, is now produced, equal in firmness and durability to the natural product, and 20 per cent better for electrical insulating purposes. The accumulator boxes used in submarines are made of this hard rubber. Soft rubber is more difficult to make. At ordinary temperatures the product is not elastic but leatherlike. It becomes elastic as its temperature is raised. The addition of dimethyl aniline and toluidine increases the elasticity of the manufactured material. It is now used for tires for heavy road motors. A factory of large extent has been built at Leverkusen, capable of producing 2000 tons annually.

CORROSION OF BRASS TUBES

Two cases of condenser tubes of brass which had been badly corroded by electrolysis, says *Engineering*, were examined by the *Materialprüfungsamt*, near Berlin, in 1916. One of the brasses originally contained the following percentages of metals: copper, 70.5; zinc, 28.8; lead, 0.21; tin, 0.28; iron, 0.08. The corroded alloy contained copper, 97.4; zinc, 0.69; lead, 0.06; tin, 0.46; iron, 0.08. The other brass gave the following analysis: copper, 59.2; zinc, 40.37; no tin; iron, 0.32; lead, 0.24. The corroded alloy had the composition: copper, 96.76; zinc, 1.29; no tin; iron, 0.10; lead, 0.05. In both cases, hence, the corrosion had bleached out the zinc and had also diminished the small percentage of lead, while there was little or no change in the iron. That the ordinary water of the supply main may give rise to considerable differences of electric potential is shown by the water of Charlottenburg, a suburb of Berlin. In this water, couples of zinc and brass acquire a potential difference of 0.888 volt. In view of the actual wide uses of substitutes for metals and alloys, the Prussian government has drawn attention to this danger of electrolysis.

TOOL STEELS

Two varieties of tool steel are described in folders sent out by Messrs. Edgar Allen and Co., Sheffield. One of these, known as Red Label, is a tungsten crucible steel for twist drills, taps, milling cutters, and similar tools. It possesses the qualities of deep-hardening and density of structure, and, as compared with ordinary carbon tool steels, shows from 75 to 100 per cent more torsional resistance; and, though it is not a high-speed steel, it will take a much higher friction heat than ordinary carbon steel. After being heated carefully and thoroughly to darkish cherry-red, say 1400° to 1436° F., it is hardened in clear water at about 60° F. though small sections may be hardened at an even lower temperature. The second steel, K 90, is intended for tools in which extreme accuracy is required, and with it the expansion and contraction ordinarily set up in the hardening process are stated to be practically eliminated. It should be heated slowly and thoroughly to a cherry-red heat, say 1436° to 1472°, and quenched in oil. Both steels are sent out annealed and ready for machining.

COMPRESSION STRENGTH OF GLASS AND QUARTZ

Some new experiments on the crushing strength of glass and quartz conducted by G. Berndt, Berlin-Friedeman, were communicated last December to the *Deutsche physikalische Gesellschaft*. The experiments were made on the Amsle testing machine, maximum load 30 tons, first with cubes of the glasses and quartz and then with cylinders. It was observed that when cubes were used the strength decreased as the cube edge was increased, in steps from 5 mm. up to 15 mm.; the cylinders afterwards used had a diameter of 5 mm. and the same height. The faces were either all polished or only those faces were polished to which pressure was applied; this made little difference and the rate of applying the load had likewise little effect on the results. With stained glass, but well annealed, the strength was smaller by 10 per cent with quick loading than with slow loading. The final crushing to powder took place with almost explosive violence. A borosilicate glass showed an average strength of 15,200 kg. per sq. cm. when strained and a higher average of 16,900 kg. (maximum, 18,400 kg.) when well annealed. In the case of quartz the crushing strength was smaller by 25,000 kg. per sq. cm. when compressed parallel to the optical axis than when the pressure was at right angles to the axis (25,000 kg. to 27,000 kg.). These values for quartz are somewhat higher than those found by Winkelmann, but lower than those found for glass.

FATS AND OILS IN GERMANY

Before the war, says the *Zeitschrift für angewandte Chemie*, the annual production of vegetable oils in Germany was about 20,000 tons of animal fats, exclusive of cheese, about 1,000,000 tons, of mineral oil some 150,000 tons. To meet the demand there were imported 270,000 tons of animal fats, 570,000 tons of vegetable oil and 1,000,000 tons of mineral oil. The demand for animal fats may be satisfied by home production which in times of peace may be greatly increased. Among the imports of animal fats, American produce figures largely. Vegetable oil came for the most part from overseas, but largely in the form of fruit from which the oil was extracted in Germany, such as linseed, rapeseed, cottonseed, palm kernels, soy beans, sesame, etc. These have been imported from Africa, South and East Asia, and the Argentine. In recent years, oil instead of soy beans has been imported from East Asia. The chief source of mineral oil has formerly been the United States; in future it is likely to be Roumania.

DAMASCENE STEEL

In the Middle Ages, Indian steel, famous under the name of damascene steel, was a product of great importance. A note on the subject by Col. N. T. Belaieus appears in the *Journal of the Royal Society of Arts*. The Hindoos, particularly, seem to have excelled in the manufacture of iron and steel, and the famous wrought iron pillar at Delhi and other instances of their skill still exist. In some of the specimens high carbon crucible steels were undoubtedly used. Small cakes of the steel were examined by Réaumur and also by Faraday whose investigations led to useful results. The fine watering of these Damascus blades shows the great amount of mechanical treatment to which they were subjected, the Oriental maker never exceeding a temperature of about 700° C. From the point of view of after-war trade, the damascene process is of considerable interest.

CHINESE PENCIL FACTORY

An Anglo-Chinese enterprise has been started in Shanghai to manufacture lead pencils. This is the first undertaking of this character in China though there are several such factories in Japan. The raw materials used at present are American wood and graphite, while the machinery was made in Japan. Though the factory is at present on a very moderate scale, the possible output is estimated at 100 gross pencils per day and there seems to be no reason why these China-made pencils should not compete successfully with the foreign-made articles chiefly imported from enemy countries before the war. It will, at any rate, be possible to turn out a very cheap article and the quality promises to be sufficiently good to satisfy the needs of the China market.

JAPANESE-CHILEAN NITRATE ENTERPRISE

It is reported by the *Japan Advertiser* that efforts are being made to undertake an enterprise for the working of niter deposits in Chile under Japanese and Chilean joint management. There has been a steady increase in the import of Chilean niter into Japan. In 1914 it amounted to no less than 24,000 tons, but the figure for last year increased to 53,000 tons. At present the total consumption of niter in Japan amounts to about 60,000 tons. It is said that to obtain this quantity by working deposits in Chile requires a capital of no more than $1,000,000 and some Tokyo business men are making efforts to undertake the enterprise in coöperation with Chilean business men. The Chilean government sold 15 niter concessions by tender on August 1, 1918.

DRYING OVENS

Gas-heated drying ovens for enameling, lacquering, core drying, armature drying, and other operations carried out at temperatures up to 500° F. are described in a list published by the Davis Furnace Company, of Luton, England. The most usual types are the double-cased, with two casings, the intervening space being packed with 2 in. of non-conducting material and the products of combustion circulating through the heating chamber on their way to the flue outlets; and the treble-cased, in which the space between the two outer casings is packed with non-conducting material and the products of combustion circulate round the inner casing, so that the burnt gases do not come in contact with the work to be heated. Natural draft burners consuming gas at ordinary main pressure are employed for heating, though the burners can be modified to use producer gas when necessary in places where town gas is not available. A thermometer is provided in each oven for temperature regulation which can be accurately effected. To facilitate handling and reduce transport charges, the ovens, the double-cased type of which are made in various standard sizes ranging up to 9 ft. by 6 ft. by 6 ft. over all and the treble-cased up to 6 ft. by 5 ft. by 7 ft., are supplied in sections to be bolted together on arrival.

RIVETING RECORDER

There is danger in riveting steam boilers by hydraulic pressure that the pressure on the cup may be released before the shank of the rivet has had time to cool. In such an event the plates may spring apart to such an extent that the shrinkage of the rivet in cooling is not sufficient to ensure a tight seam. In a German technical paper a description was recently published of an automatic recorder designed to overcome this possible defect of hydraulic riveting. Pressure upon the warm head of the rivet is transmitted through piping to clockwork and sets a pointer in motion until the required pressure is reached. This pressure is kept constant until a predetermined number of seconds has passed when a red pointer indicates that the pressure may be released and the pointer returns to zero. This result is graphically recorded upon a traveling paper band from which the pressure and the period of compression can easily be read.

PLATINUM SUBSTITUTE

A platinum substitute tested, according to the *Chemical Trade Journal*, in Amsterdam, was an alloy of 89 per cent of gold with 11 per cent platinum. This material, called *platino*, withstood sulfuric, hydrochloric, and nitric acids, and other reagents used in chemical work and was unaffected by heating for 1/2 hr. in a smoky petroleum-gas flame. It proved equal or superior to platinum in ware for the chemist's laboratory except for the large loss by corrosion when used in contact with a mixture of sulfuric and nitric acids.

NEW SOUTH AFRICAN INDUSTRIES

During the year 1917, the following new industries, according to the Report of the Industries Advisory Board, are known to have been initiated in the Union of South Africa and, in many cases, to have commenced production: manufacture of calcium carbide, chloride of lime, alcohol motor fuel, shoe and floor polishes, sulfate of ammonia, asbestos, arsenic, starch from maize, paints and distempers from local materials, glue and size, wax, also tin and antimony, smelting, wattle bark extraction, and detinning of scrap tin. In addition, a cement factory capable of manufacturing 720,000 bags of 188 lb. each has commenced work near Mafeking.

AEROPLANE CONSTRUCTION

A catalog issued by Messrs. Accles and Pollock, Birmingham, gives full-size illustrations, with equivalent diameters of the special sections of weldless steel tubing they make for aeroplane construction and other purposes. The sections are to be numbered in hundreds and are of all forms—square, rectangular, round-end oval, pointed oval, D, half-round stream line, etc. There are tables giving the areas of sections of circular tubes and the approximate weight in lbs. per ft. of all outside diameters from 1/16 in. up to any size in 16ths for Imperial standard gauges No. 6 to No. 26, and illustrations are added of wire strainers and other ferrules made from solid drawn weldless steel tubing and of various polished aircraft parts manufactured by the firm.

NEW STEAM MOTOR

A new form of steam motor which is expected to supersede the internal combustion motor has been invented according to the Danish press, by a well-known Danish engineer. The new motor is mobile and the steam is supplied by pumping water intermittently into a spiral where it is vaporized by a blowpipe flame. The water circulates and is used again as in a motor cooler and in much the same quantity. The motor has three cylinders but has the same effectiveness as a six cylinder internal combustion motor. It does not weigh more nor occupy more space than an ordinary benzene motor. It is capable of using the most inferior crude oils as fuel. It is simple in working, can be easily controlled, and is said to be specially suitable for use in fishing boats. Patent rights have been sold both in Norway and Sweden.

A NEW PLASTIC COMPOUND

The noninflammable and odorless plastic material described in a late French patent is made from gelatin, glue, or other animal product by the action of suitable chemicals. After melting the gelatin or glue on a water bath at about 200° F., a decoction of hop flowers is prepared and added in a mixture with dilute oxalic acid. Impurities are thus caused to settle at the bottom. The liquid gelatin is poured into sheets or strips, dried in cold air, and then colored with natural or artificial dyes. The sheets are then treated with a bath of 25 to 30 per cent or more each of formaldehyde, water, and alcohol, with a little oxalic acid, tannin, and glycerin, after which they are dried in hot air.

IRON AND STEEL TRADE OF ADEN

The iron and steel trade of Aden can not be considered as large nor as offering a growing opportunity for manufacturers, but, due to the cessation of practically all civilian building, owing to the difficulty in getting material, a field will be open to manufacturers who can make prompt after-war deliveries. The iron and steel used at Aden is principally for construction of lighters and buildings, for the repair and maintenance of small plants used for manufacture of ice and condensing of water, and for repairs to ships. The slight increase noted recently in imports of nails, rivets, washers, etc., is due largely to the fact that as no material is obtainable for construction of new lighters it is necessary to make extensive repairs to the present lighters. The decrease in imports of "bar and channel iron" and "beams, pillars, etc.," indicates how the normal demand for building materials have fallen off. Several builders have expressed a desire to import iron and steel for building purposes from the United States, but have been deterred by the high freight rates and the cost of material.

SCIENTIFIC SOCIETIES

RESOLUTION CONCERNING ORGANIC NOMENCLATURE

Editor of the Journal of Industrial and Engineering Chemistry:

The following resolution was passed unanimously by the Division of Organic Chemistry at the meeting of the American Chemical Society, held at Hotel Statler, Cleveland, Ohio, September 12, 1918:

> Whereas, *The Journal of the American Chemical Society* and *Chemical Abstracts* have adopted and consistently employ the pure English terms "benzene," "toluene," and "xylene," including all of their derivatives, in place of the hybrid forms "benzol," "toluol," "xylol," etc.; and
>
> Whereas, these English terms alone are to be found in publications devoted to pure organic chemistry, both in this country and Great Britain; and
>
> Whereas, industrial and technical journals have become lax in their use of these strictly correct English forms; and
>
> Whereas, the one-time confusion between the words "benzene" and "benzine" now no longer exists, owing, primarily to the discontinuance of preparation of this latter named product, and, again, to a recent and well-made suggestion of the term "benzolene" for this same petroleum benzine fraction, if later to be placed on the market;
>
> *Therefore be it Resolved,* that the members of the Division of Organic Chemistry of the American Chemical Society shall hereafter encourage the use of these English terms exclusively, where and whenever opportunity permits.
>
> It is requested that a copy of this resolution shall be sent to the Editor of the *Journal of Industrial and Engineering Chemistry,* with the hope that the German terms aforementioned may be replaced by the English throughout the pages of the Industrial Journal, both in its editorial and advertising matter. By this means we shall maintain a consistency in organic nomenclature throughout all publications of our Society.

As stated herein, it is the wish of our Division that you and your associate editors immediately consider our resolution and transmit the same to other journals of the industrial chemical world.

William J. Hale,
Secretary

....

The above resolution was unanimously endorsed by the Division of Industrial Chemists and Chemical Engineers at the Cleveland Meeting (see page 866, October issue), and has also been endorsed by the Advisory Committee of the American Chemical Society. In view of this unanimous expression of opinion we shall endeavor to carry out the recommendation contained in this resolution in the editorial columns of This Journal.—[Editor.]

AMERICAN ELECTROCHEMICAL SOCIETY
34TH GENERAL MEETING, ATLANTIC CITY
SEPTEMBER 30 TO OCTOBER 2, 1918

The meeting at Atlantic City, September 30–October 2, 1918, was another demonstration of the feasibility and desirability of war-time scientific meetings. Eighty-two members and thirty-two guests constituted an interested body which listened attentively to the papers, started lively discussions, and gave an air of attention-to-business to all the proceedings.

Princeton had been selected for the meeting place, and a full and interesting program had been arranged to the last detail, but the commandeering of colleges and universities by the Government on October first made Princeton unavailable, and a quick change to Atlantic City was effected at the last moment.

Headquarters were at the Hotel Traymore, and many members attending the Chemical Exposition at New York the previous week found a welcome relaxation in spending Sunday at the shore. The sessions were held in the convenient Belvedere room, whose windows command a spacious view of the island and surf-edged beach.

Monday morning's program included papers on "An Apparatus for the Separation of Radium Emanation and its Determination Electroscopically" by J. E. Underwood and Prof. Schlundt, of the University of Missouri; "Notes on the Heterogeneous Equilibrium of Hydrogen and Oxygen Mixed with Radium Emanation" by S. C. Lind, of the Bureau of Mines, Denver; "Processes Within the Electrode which Accompany the Discharge of Hydrogen and Oxygen," by Prof. Donald P. Smith, of Princeton; "The Sign of Potential," by Prof. O. P. Watts, of the University of Wisconsin. The discussion of the latter paper was particularly lively, Prof. Watts pleading for the retention of the usual designation of the stronger metals as the more electropositive and the retention of the parallelism between chemical activity and electrical potential. His main argument was the uniformity thus introduced in the signs of the electrodes and the direction of the current in consonance therewith, in electrolytic and battery cells.

In the afternoon session F. C. Kelley read a paper on "The Hardness of Soft Iron and Copper Compared," in which he showed that annealing in hydrogen gave unexpected softness to pure iron. E. Kilburn Scott described at length "Nitrogen Fixation Furnaces," touching on the salient and characteristic features of various types of arc furnaces in a masterly manner. W. R. Mott, of the National Carbon Company's research laboratory, contributed a remarkable paper on "The Relative Volatilities of Refractory Materials," in which he tabulated ten different methods or lines of observation which give data on the volatilities of various refractory metals and oxides in the electric arc. The long paper contained a mass of new and interesting observations and data, from which perhaps only a fraction of the possible conclusions and inferences were drawn by the author; a number of such were brought out in the discussion.

In the late afternoon, at a meeting of the Board of Directors of the Society, the 1919 Spring Meeting was scheduled for New York City, the Fall Meeting for Chicago, coincident with the Fifth National Exposition of Chemical Industries, and a $2000 subscription to the Fourth Liberty Loan was voted.

The evening gathering in the beautiful Rose Room (which happened to be lined with an exhibit of the wonderful Farré airplane pictures) furnished relaxation in the form of moving pictures: "The Fixation of Atmospheric Nitrogen at Niagara Falls," by courtesy of the American Cyanamid Co.; "Canadian Shawinigan Falls Power Development and Electrochemical Industries," by courtesy of the Shawinigan Water and Power Co.; and "The Triplex (Bessemer–Open Hearth–Electric) Steel Process at South Chicago," by courtesy of the U. S. Steel Corporation. The pictures formed a very satisfactory substitute for the usual visits to industrial plants; such exhibitions are valuable adjuncts to a scientific meeting.

Tuesday was given, morning and afternoon, to discussing "Electrochemistry After the War." A. H. Hooker, of Niagara Falls, discussed the chlorine and alkali industry; Van R. Kokatnur, of Niagara Falls, the multitudinous uses of chlorine; W. L. Landis, of the American Cyanamid Co., air nitrates; F. A. J. FitzGerald, of Niagara Falls, the electric furnace; J. A. Mathews, of the Holcomb Steel Co., Syracuse, electric steel; Robert Turnbull, of St. Catherine's, Canada, electric furnace pig iron (the low-phosphorus pig made in steel-melting furnaces from steel scrap); C. A. Winder, of Niagara Falls, the power situation; J. W. Beckman, of San Francisco, the same topic, from the Pacific Coast standpoint; Grinnell Jones, of the U. S. Tariff Commission, tariff problems of the electrochemical industries; Lt. Col. W. D. Bancroft, U. S. A., scientific research; Dr. Mees, of Rochester, the question of coöperative industrial research. The general note in all these discussions was optimism, tempered by a realization of the magnitude of the tasks and the necessity of scrapping old ideas and facing bravely the new situations which have arisen.

In the evening Dr. E. F. Northrup, of Princeton, gave an informal account of how he came to devise his interesting and potentially important "Oscillatory Current Induction Furnace." His non-mathematical presentation, giving a direct and clear insight into the characteristics of the furnace, held the attention of the gathering for nearly two hours. The next morning the meeting of the Society adjourned direct to Trenton, N. J., where Dr. Northrup, at the works of the Pyroelectric Instrument Company, concluded his lecture by demonstrating the furnace in operation, melting a charge of nickel. A visit to the Thermoid Rubber Company plant, after lunch, concluded a meeting which was a pleasure and an inspiration to everyone fortunate enough to be in attendance.

J. W. Richards

Lehigh University
South Bethlehem, Pa.

THE MILWAUKEE MEETING OF THE AMERICAN INSTITUTE OF MINING ENGINEERS

On October 7 to 12, 1918, Milwaukee was host to the American Foundrymen's Association, the American Institute of Mining Engineers—the Institute of Metals Division and the Iron and Steel Section, and the American Malleable Castings Association. In addition to the joint and separate meetings of these bodies, the huge auditorium hall was filled with an industrial exhibition of metals and metal-working accessories which was worth going a long way to see.

All the Societies joined in an opening session on Tuesday morning, at which President Backert, of the Foundrymen's Association, presided; Governor Philips, of Wisconsin, welcomed the visitors in a patriotic speech; a long and interesting letter from Captain R. A. Bull, a former president of the Association and now in France, was read, and a ringing resolution was passed, to be telegraphed to President Wilson, pledging anew to the Government every resource of the allied metal trades until "the abject and unconditional surrender of the enemy."

Following this, the gathering resolved itself into various sectional meetings, unfortunately scheduled simultaneously, thus rendering it impossible to hear all the papers in which one might be interested. Several in this predicament were heard drawing a parallel between this convention and a four-ring circus. The criticism was a valid one; the program should have had the sectional meetings arranged consecutively, using both mornings and afternoons, so as to prevent the keen disappointment felt by those forced to choose between one meeting and another.

The Foundrymen's Association had a schedule of papers on various subjects, from moulding sands to core ovens, electric furnaces, and pyrometers. Owing to the impossibility of being in three places at once, the writer can only report what was verbally reported to him, *viz.*, that the attendance on these technical sessions was poor and the discussion of the papers tame, excepting the discussion on casting semi-steel shrapnel shells. Evidently the foundrymen are stronger in action than they are at talking, a virtue which, we will readily admit, has its commendable features.

The Institute of Metals Division of the Mining Engineers (W. M. Corse, *Chairman*), on the other hand, held well attended sessions at which discussion was lively and the interest so great that they extended an hour or more beyond the normal closing hours. Almost all the papers on the program had been printed in advance in the Bulletin of the Institute, giving ample opportunity for preparation of careful and well-considered discussion. Professor Zay Jeffries described "The Metallography of Tungsten," attempting therein to show the causes of its brittleness; Sir Robert Hadfield, of Sheffield, England, communicated some discussion mainly bearing on the explanation of the effect of tungsten on the electrical properties of steel. S. L. Hoyt discussed in a new way the ever-present problem of "The Constitution of the Tin Bronzes;" his conclusions did not find unanimous approval. Jesse L. Jones, of the Westinghouse Company, considered "Babbitt and Babbitted Bearings," his main point being that the genuine "Babbitt" was improved by reducing its tin content by the addition of 1 per cent of lead. Two papers by S. Skowronski treated of "Oxygen and Sulfur in the Melting of Copper Cathodes" and "The Relation of Sulfur to the Over-Poling of Copper;" N. B. Pilling discussed "The Action of Reducing Gases on Copper."

Another session was devoted to a "Symposium on the Conservation of Tin." A dozen men prominent in the white metal industry read carefully prepared addresses, and a general discussion of a most interesting nature followed, the session lasting from 10 A. M., to 1.30 P. M., and being continued into the afternoon session at 3 P. M. The savings possible by reducing the tin in solders, using substitutes for tinfoil, packing dry foods in cartons instead of tin boxes, using copper-coated iron for boxes intended to be printed, saving the fumes from melting down old tin scrap to sash-weight-iron, making dry tin skimmings, etc., etc., almost *ad infinitum*, were thoroughly considered. It was a unique session of absorbing interest.

At the concluding session, Dr. John Johnston read an interesting résumé of the existing data on "The Volatility of Zinc from Brass," and discussed the figures in an able manner. Although the data are scanty, yet they allow some definite conclusions to be drawn as to the vapor tension of zinc from these alloys at various temperatures, and the consequent liability to loss of zinc in melting and pouring them. Dr. J. W. Richards discussed the question from the thermodynamic standpoint, pointing out that the vapor tension curve of pure zinc was well known, and that if the heats of combination of zinc with copper to form these various brasses were determined calorimetrically, the vapor tension of zinc from these alloys could be calculated with precision; further, if their latent heats of fusion were also determined, the vapor tension of zinc from the solid brasses could be calculated. The further discussion emphasized the advisability of *coöperative industrial research*, subsidized by the brass manufacturers, to determine such lacking data and make them available to the industries. G. C. Stone, of the New Jersey Zinc Co., described "The Effect of Impurities on the Hardness of Cast Zinc;" C. A. Hansen's paper on "Electrolytic Zinc" was, in the absence of the author, read by title; Prof. C. H. Fulton's paper on "The Condensation of Zinc from its Vapor," was a valuable contribution towards the explanation of a difficult problem; G. F. Comstock discussed the important question of "Non-Metallic Inclusions in Bronzes and Brasses;" Dr. G. K. Burgess and L. J. Gurevich, of the Bureau of Standards, "Fusible Plug Manufacture." Dr. Arthur W. Gray had a long and painstaking paper on "Dental Alloys," principally the amalgams and their properties. Hill and Luckey described how minute quantities of lead can be determined in copper by boiling off the lead from a weighed sample, in an electric arc, and noting with a stop-watch the time required until the spectroscope shows the absence of the lead lines—a most interesting and novel method of quantitative chemical analysis.

The Iron and Steel Section (Dr. J. W. Richards, *Chairman*) was scheduled for two sessions, one dealing principally with iron and steel and the other with coal and coke. The first session opened with an exhibit of moving pictures of the Triplex Steel Process (Bessemer–Open Hearth–Electric) at the South Chicago works of the Illinois Steel Company, Dr. Richards furnishing explanations of the process and the pictures. Dr. John Johnston, of the National Research Council, read a paper on the work of the Council, written by H. M. Howe. Papers on "The Limonite Deposits of Mayaguez Mesa, Porto Rico," and "Recent Geologic Development on the Mesabi Iron Range," were read by title. "The Manufacture of Ferro-Alloys in the Electric Furnace," by R. M. Keeney, was an up-to-date presentation of a very important topic, containing particularly new information concerning ferro-uranium. "The Manufacture of Silica Brick," by H. LeChatelier and B. Bogitch, was mostly a detailed discussion of the microscopic characteristics and the constituents of bricks burned at different temperatures—it should have brought out an active discussion, but it did not. Two interesting papers followed on partly distilled coal—carbo coal and semi coke, by C. T. Malcolmson and G. W. Traer, respectively. The discussion was lively and brought out very clearly the fact that such products are looked to, in the Middle West, to replace anthracite coal for household use—an object of great national importance. W. H. Blauvelt's paper on "The By-product Coke Oven and its Products," dealt with nearly the same topic. H. R. Collins, of the Fuller Engineering Company, discussed "The Use of Coal in Pulverized Form," which led to considerable discussion, in which Mr. Adams, of Milwaukee, described the installation of powdered coal firing in locomotive boilers in Southern Brazil, using coal with 4 to 5 per cent sulfur. Mr. Adams also invited all present to visit the Milwaukee Power Station, where a steam boiler was running regularly on powdered coal, at high thermal efficiency. Those accepting his invitation saw a very simple and effective installation, which will doubtless soon be copied in power plants all over the country.

The meeting as a whole was a great technical success and fulfilled admirably its function of instructing and stimulating to greater industrial and scientific achievement the metallurgists and engineers in attendance. J. W. RICHARDS

LEHIGH UNIVERSITY
SOUTH BETHLEHEM, PA.
October 15, 1918

REPORT OF THE COMMITTEE ON RESEARCH AND ANALYTICAL METHODS, FERTILIZER DIVISION, AMERICAN CHEMICAL SOCIETY

Cleveland, September 11, 1918

Two subjects have been under consideration by this Committee:

The first was the report of Mr. H. C. Moore, who was appointed to work out a suitable method for the determination of sulfur in pyrite to replace the faulty Lunge method. His work developed the value of a modification of the Allen and Bishop method and has been under way for several years. The coöperative work this year has given results which are even more satisfactory, if anything, than those of previous years and are being reported by Mr. Moore in a paper to be read before the Division at this meeting, with the recommendation that the method be adopted.

The other was the DeRoode method for determining potash, which was brought to the attention of the Committee from several quarters. A modification of this method was published by T. E. Keitt and H. E. Shiver in the *Journal of Industrial and Engineering Chemistry* for March 1918.

The results obtained by this method are, in general, considerably higher than those obtained by the official method and the results of preliminary work do not indicate that this is due to impurites or other sources of error.

PAUL RUDNICK, *Chairman*
F. K. CAMERON
A. J. PATTEN
C. H. JONES
J. M. MCCANDLESS

NOTES AND CORRESPONDENCE

THE CENSUS OF CHEMISTS

Editor of the Journal of Industrial and Engineering Chemistry:

General Sibert directs me to extend to you the thanks of the Chemical Warfare Service of the United States Army for your assistance in the census of American chemists recently made by this arm of the service. Without the aid of your Journal it would have been impossible to have gained such wide publicity for the enterprise, or to have obtained such a prompt and altogether satisfactory response from the great body of loyal chemists of this country. Well over half of the questionnaires have been answered, and the rest are daily being received in such numbers as to indicate the completion of the task at a not far distant date. The War Department is thus put in possession of an invaluable set of records at extremely small expense.

While the purpose of the questionnaire has been understood by nearly all of those who have replied to it, there have been a few instances in which it has been mistakenly interpreted as a call to immediate service. In order to avoid any misunderstanding it should be explained that the purpose of the census is primarily to put the War Department in control of complete information as to the chemical man power of the country, not to gain immediate recruits for the Chemical Warfare Service. At the present time the vacancies in the Service are comparatively few in number. When vacancies occur in the future, reference will be had to the tabulated information gleaned from the present census, and appointments will be made from the names on file, attention being paid to the applicant's technical qualifications, desire to serve, etc.

The great majority of American chemists will undoubtedly never be called upon to serve in a military capacity in the present war. The Government, however, must have complete information concerning all chemists, in order that it may select those best fitted to perform its work, and at the same time interfere as little as possible with established essential industries. The chemist who, after returning his complete questionnaire, receives no call to service, may take it for granted that the Government cannot, for the time being, utilize his services. In the meantime three things are asked of him:

1—To keep the Chemical Warfare Service informed of any change in his address, his employment, his draft status, or anything else which might have a bearing on his case.

2—To notify the Chemical Warfare Service at once if he is drafted *and called to camp*. In such a case he should give his complete military address.

3—To help stabilize the industry of the country by continuing steadily at essential work until the Government notifies him that his services are needed elsewhere.

In addition it is requested that all persons send to the Chemical Warfare Service the names and addresses of any chemists of their acquaintance who have not already received the questionnaire. Chemists who have already received the questionnaire but who have not yet returned it should do so *at once*, in order that the Government may not be put to the trouble of sending out a large number of "follow-up" letters. Any chemist who has not received the questionnaire should write for a copy, addressing his request to the Personnel Section, Administration Division, Chemical Warfare Service, U. S. A., 7th and B Streets, N. W., Washington, D. C.

F. E. BREITHUT
Major, Chemical Warfare Service, U. S. A.
Chief of Personnel

WASHINGTON, D. C.
September 30, 1918

DEFERRED CLASSIFICATION AND FURLOUGHS FOR GOVERNMENT AND STATE CHEMISTS

The Chemical Warfare Service has been duly authorized, by order of the Secretary of War, to make the necessary arrangements through the Adjutant General's Office, to secure the furlough, without pay or allowances, of such chemists as are necessary in such government bureaus as the Bureau of Standards, Bureau of Chemistry, Bureau of Mines, United States Patent Office, where such chemists are engaged in chemical work for the government or state bureaus concerned, essential to the prosecution of the war. At the same time they are advised that the new Selective Service Regulations, to be published shortly, will emphasize to the draft boards the fact that skilled employees of war industries should be placed in deferred classification. The induction into the military service of skilled men necessary to essential industries or occupations, to be subsequently furloughed back to their industries or occupations, involves an expense to the Government, and the men concerned lose time from their necessary work. The bureaus concerned are authorized by the Selective Service Regulations to submit to the draft boards affidavits and written proof to maintain their contention that their employees should be placed in deferred classification and it is believed that they should be encouraged in securing deferred classification rather than securing the furlough of the men after they have been inducted into the military service.

All communications in regard to information from those desiring any details should be addressed to Major Victor Lenher, Chemical Warfare Service, U. S. A., Chief, Governmental and State Relations Branch, Unit F, Corridor 3, Floor 3, 7th and B Sts., N. W., Washington, D. C.

CHEMICAL INDUSTRY IN THE NETHERLANDS

In a recent number of the Dutch publication, *In- en Uitvoer*, Mr. Jan Straub gives a brief history of the chemical industry in the Netherlands. The writer points out that the present backwardness of the industry is the natural result of the lack of minerals in the country and of the fact that in the Netherlands, agriculture and trade have for ages been the principal sources of wealth. In Germany, on the contrary, the great mineral wealth furnishes valuable opportunities for the employment of the growing population. The chemical industry in the Netherlands owed its origin to the needs of agriculture, but its progress was retarded by the ease with which chemicals could be imported from Germany and from oversea countries, as well as by the limited demand at home. The Dutch simply followed the practical maxim according to which it is better to buy cheaply than to produce dearly. In recent years, however, the demand for chemicals has increased greatly in Holland, particularly for export to the colonies, and the war has induced the Dutch to make extensive investigations in order to ascertain what chemicals and preparations could be made at home just as cheaply as elsewhere. The methods and processes of production have been studied during the war in various establishments, and the factories are ready to begin production as soon as peace returns and the raw materials become available.

The manufacture of essential oils is a comparatively new branch of the chemical industry which is always certain of a market for its products. It supplies soap factories, manufacturers of artificial fruit flavorings, and distillers with the means for the refining of their products. The manufacture of toilet soaps, fruit syrups, and fine liquors is on the increase, and the demand for essential oils and compound ethers is growing. The oils and the salts are prepared under scientific supervision, and the manufacturers are profiting by the experiences of their customers. They will be in a position to compete with foreign producers after the war.

The production of pure chemicals and drugs has developed rapidly under the stimulus of the war. The increasing demand for all sorts of inorganic and organic preparations both for industrial and medicinal use will provide a market for these products also in times of peace, both at home and in the Dutch East Indies. It may well be that many of these preparations, when peace returns, will be obtainable from abroad at a price below the domestic cost of production. In that case, even if domestic production shall be discontinued, some good will have been accomplished nevertheless; the Dutch purchasers will know the limits of the prices which may be demanded of them.

Only a few of the coal-tar dyes were formerly manufactured in Holland here and there, but the necessary intermediate products had to be imported. During the war, steps have been taken to build up the industry systematically from the simplest raw material to the finished product. The increased production of the Limburg mines, the new coke ovens, and the expansion of the tar-distilling industry promise to furnish a sufficient quantity of intermediates. For the present the intermediate products are given the chief attention, as they have their own markets, and the production of finished dyes, one after the other, will follow later. The first products will doubtless be taken by the Dutch textile factories, which will thus become independent of foreign or rather German producers. The Dutch factories are also getting ready to produce various perfumery articles, drugs, and tar distillates, but refrain from making known the results achieved until the time comes when they may begin deliveries.

PORTRAIT OF CHARLES M. HALL FOR THE CHEMISTS' CLUB

On the evening of October 11, 1918, previous to the regular meeting of the New York Section of the AMERICAN CHEMICAL SOCIETY, a portrait of the late Charles M. Hall, presented to the Chemists' Club by the Aluminum Company of America, was unveiled. Mr. Ellwood Hendrick, President of the Chemists' Club, in his introductory remarks, spoke briefly of the life of Mr. Hall and of his work on aluminum. He then called upon Mr. Duggan, Chairman of the House Committee, to unveil the portrait, after which the artist who painted the portrait, Mr. Rood, was asked to tell something of the process of making a likeness of a man whom he had never seen. This, Mr. Rood explained, he had done by means of various photographs of Mr. Hall and of talks with men who had known him.

In the absence of Mr. Arthur V. Davis, President of the Aluminum Company of America, who had expected to be present to give personal recollections of Mr. Hall, Mr. Hendrick called upon Dr. C. F. Chandler, who told the story of Mr. Hall's discovery, at the age of twenty-two, of the solubility of alumina in fused cryolite and all that this discovery has meant industrially.

The portrait of Mr. Hall now hangs in the Lounge Room of the Chemists' Club. He is the third Perkin Medalist whose portrait has been hung on the walls of the Club, and Dr. Chandler said that he hoped to live to see a portrait of each one of them hanging in the Club.

COÖPERATION REQUESTED BY THE ALIEN PROPERTY CUSTODIAN

Editor of the Journal of Industrial and Engineering Chemistry:

I will greatly appreciate it if you will call the attention of the readers of your publication to the provision of the "Trading with the Enemy Act," which provides that all money or other property held by, for, or for the account of, or the benefit of, an enemy or ally of enemy, should be immediately reported to this office. This includes patents, trade-marks, copyrights, prints, labels, and designs.

In connection with the last named, the following persons are required to make report to this office:

> All persons who are in any manner interested in the use or operation of any enemy-owned patent, trade-mark, copyright, print, label, or design, including joint inventors, where one of the inventors is an enemy within the provisions of the "Trading with the Enemy Act."
>
> Assignees of an undivided part or share of an invention, or right to carry on a process or operate under a trade-mark, copyright, print, label, or design, within and throughout a specified portion of the United States, when such patent or process is enemy-owned.
>
> Mortgagees and licensees of enemy-owned patents, trade-marks, copyrights, prints, labels, or licenses.
>
> The above includes guardians, executors, and administrators.

Any information regarding the enemy interests in any patents trade-marks, copyrights, prints, labels, or designs, should be forwarded immediately to Francis P. Garvan, Director of the Bureau of Investigation, Alien Property Custodian's Office, Washington, D. C., even if the information is only gossip or rumor. Oftentimes a clue to important enemy interests is obtained in this way. I feel sure than I can count upon your coöperation in the work of uncovering money and property of enemy character. The money thus obtained is invested in Liberty Bonds, and is made to fight for our country, instead of against it.

SIXTEENTH AND P STREETS, N. W.
WASHINGTON, D. C.
October 1, 1918

A. MITCHELL PALMER
Alien Property Custodian

AN ALINEMENT CHART FOR THE EVALUATION OF COAL—CORRECTION

In the article of the above title, THIS JOURNAL, 10 (1918), 627, the 4th line in "Directions for Use" under the cut should read "Price per dry ton" instead of "Cost per million B. t. u."

September 12, 1918 A. F. BLAKE

PERSONNEL, RESEARCH DIVISION, CHEMICAL WARFARE SERVICE—CORRECTION

It is regrettable that in the rush of assembling the names of the men engaged in work for the Research Division of the Chemical Warfare Service, for publication in the September issue of THIS JOURNAL, the name of Professor Treat B. Johnson, of Yale University, was omitted from the list.

WASHINGTON LETTER

By PAUL WOOTON, Union Trust Building, Washington, D. C.

No hedging against the end of the war is being done by the Government. Contracts are being let, plants are being built, and all plans are being made as if it were sure that the war will last two years more. While this is no more true of chemical activities of the Government than of any of its other war activities, it can be stated on the best of authority that the apparent collapse of the Teutonic fighting machine has in no way been reflected in the activities of the agencies conducting the chemical work being done by the Government. Incidentally, the ban on publicity, which has been clamped over this work since the beginning of the war, remains in place. Matter, which would be 90 per cent useful to the chemists of the United States and 10 per cent useful to Germany, is withheld with all rigorousness, along with much information which apparently would not be of value to the enemy.

The War Minerals Bill became a law at 2 P.M., Oct. 5. This Act, which affects importantly nearly every chemical industry, must await the issuance of regulations before its effects are felt generally. At this writing (Oct. 16) the President's proclamation, which will designate the agencies to administer the Act, is being expected daily. It is regarded as probable that power will be divided between the Bureau of Mines and the War Industries Board. Certainly price fixing and allocation of materials will go the the War Industries Board as it already is handling all such matters for the Government.

Prices for sulfuric and nitric acids have been agreed upon by the War Industries Board and the Committee on Acids of the Chemical Alliance, effective until the first of the year, as follows:

Sulfuric Acid, 60°	$16.00 per ton (2000 lbs.)
Sulfuric Acid, 66°	25.00 per ton (2000 lbs.)
Oleum, 20 per cent	28.00 per ton (2000 lbs.)
Nitric Acid, 42°	8 1/2 cents per lb.

The same provisions for shipment in drums, carboys, in carload and less than carload lots as were made effective for the quarter ending September 30 are to continue for the last quarter of the year, but with these new prices fixed for bulk shipment used as a base for package prices.

Senter, Mich., has been selected for the site of a new Government tetryl plant. The value is to be $250,000, which is to be divided between the cost of buildings and equipment.

A $1,000,000 addition to the Frankford Arsenal has been authorized.

The Federal Trade Commission continues to insist on the discontinuance of what it terms unfair methods of competition when prices are offered which are "unwarranted by trade conditions and so high as to be prohibitive to small competitors." The American Agricultural Chemical Co., of Connecticut, and the Brown Co., Inc., of Trenton, N. J., manufacturers of fertilizers, are among the latest concerns to be accosted by the Commission. The Commission states that it found that the American Agricultural Chemical Company is the owner of all the capital stock of the Brown Company and that prices were being offered at Philadelphia and at Atlantic City for raw materials which were "calculated and designed to, and did, tend to destroy certain small competitors."

Licensing of the platinum industry is proceeding more rapidly than had been expected. The fact that the same plan has been applied to other materials, as well as the wide publicity given the regulations, is responsible for most of those concerned being conversant with the steps they are required to take. It is estimated that 150,000 licenses will be issued.

That gas masks being used by the American Army give twenty times the protection afforded by German gas masks is a fact attested to in a formal statement issued by the War Department. It is stated further that there is not a single case on record of an American soldier falling victim to a gas attack when protected by the mask that is now being manufactured in the United States on a vast quantity basis. This fact has been so thoroughly established by repeated experiences that military authorities place the blame for gas poisoning on the carelessness of the victim. A great many officers in the United States Army insist that in most cases the men who get gassed should be court-martialed, not decorated.

It is an interesting fact that American gas masks stand up under tests that German masks cannot meet. German masks will not give protection against a high concentration of gas. This was demonstrated recently when the British assembled a sufficiently large battery of projectors to put seventy tons of phosgene into the air at once, with consequences quite well known to the German General Staff. There is no concentration of gas that American masks will not defy. This has been proved, not only on the battlefield, but in the experimental stations in this country, where determined attempts to break down the resistance of United States Army masks by heavy gas concentrations were absolutely unsuccessful.

Importation of French optical glass is to be controlled by the War Industries Board. Orders for the French product must pass through the hands of the War Industries Board and the War Trade Board. Regulations for the importation of French optical glass adopted following conferences between the Military Optical Glass and Instruments Section of the War Industries Board, of which George E. Chatillon is chief, and the Bureau of Imports of the War Trade Board, provide:

> 1—All import orders for French optical glass should be placed with the Service Geographique, who will distribute them among the various French manufacturers.
>
> 2—The order, together with the application for import licenses, should be forwarded to the War Trade Board, Bureau of Imports, to the attention of Mr. Reardon.
>
> 3—The applications should state in detail the purpose for which the glass is intended.
>
> 4—The War Trade Board will in all cases consult with the Military Optical Glass Section of the War Industries Board before applications are granted.
>
> 5—Orders placed direct will not have the approval of the Military Optical Glass Section nor the necessary endorsement of the War Trade Board to allow the glass to be imported from France.
>
> 6—If glass of a special manufacturer is desired, it may be noted on the order.

Drugs and medicines used by the Army Medical Corps are being tested by the Bureau of Chemistry of the United States Department of Agriculture at headquarters here and at its offices in other cities. Several chemists have gone from the Bureau to accept commissions in the Army and perform the work directly for the War Department. Chemists and inspectors are being instructed for Army and Navy work and special investigations are being conducted on problems concerning foods, leather, fabrics, paper, and other products in military and naval demand.

In a new ruling of the War Trade Board (W. T. B. R. 254), the importation into the United States of varnish gums (Kauri, Copal, Damar, Zanzibar, Manila, Congo, Fentiansk, Bengurlla, Sandarao, and East India or Borneo gum) is restricted as to shipments made after October 10, 1918. All outstanding licenses have been revoked as to ocean shipment after that date and no new licenses will be issued except to cover the following: (1) Shipments made from abroad on or before October 10, 1918, (2) shipments for the use of the United States Government, (3) shipments from Mexico or Canada by other than ocean transportation, (4) shipments from Europe or Mediterranean Africa when coming as return cargo from convenient ports where loading can be done without delay, (5) shipments of Copal or Manila gum when shipped from the Philippine Islands, and (6) shipments of Kauri gum not to exceed a total of 3,000,000 lbs. during the calendar year 1918.

Licenses for the amounts of varnish gums permitted to come forward, pursuant to the foregoing, will be allocated by the Bureau of Imports of the War Trade Board in accordance with the recommendations, as to distribution and price, of the War Industries Board. Varnish gums are accordingly added to the list of commodities excluded from the terms of license PBF 27.

A voluntary increase in the price of castor beans has been announced by the War Department. This action will save serious loss to the majority of those who embarked in the new enterprise of growing castor beans, it is believed, and will make for a continuance of the industry in the South. The War Department's statement in this connection is as follows:

> In order to procure an adequate supply of castor oil for use in connection with the War Department aviation program, numerous contracts were let last spring for the raising of castor beans in the Southern States, at a price of $3.50 per bushel. With the harvesting of the crop it has been found that this price does not provide sufficient remuneration to the grower.
>
> After careful consideration of the matter by a board of the Bureau of Aircraft Production, Mr. W. C. Potter, the Acting Director of Aircraft Production, has established a price of $4.50 per bushel of 46 lbs. As specified in the original contracts, beans are to be delivered hulled and sacked, in carload lots, f. o. b. the nearest railroad station to the land on which they are grown.
>
> Most of the planting of castor beans was done under sub-contracts with the general contractors. The price of $4.50 now established is to be paid to the actual growers of the beans. The remuneration of the general contractors for their services in connection with the crop is in addition to this sum.

Hope had been expressed that the shipping situation would be sufficiently relieved this winter to allow increased importations of nitrate of soda. While the shipping situation has improved, in so far as additional tonnage is concerned, beyond expectations of a year ago, the demands on that tonnage also have increased beyond all estimates. For this reason, it is improbable that any large amount of nitrate of soda for other than Government use will be brought in this winter.

The list of restricted imports No. 1, item 64, issued by the War Trade Board, provided that prior to October 1, 1918, licenses might be issued for the importation of 125,000 long tons of pyrite. Since licenses have not been issued for the full amount so permitted, the War Trade Board has authorized the issuance of licenses during the remainder of the present calendar year, when the applications are otherwise in order, for the importation from Spain of the unimported balance of the amount originally authorized, which is approximately 56,400 tons.

To provide for more prompt chemical analysis of food products for use by the Army and Navy, a new arrangement has been made by the Bureau of Chemistry, which is described in the following announcement:

> Arrangements have been made by the Subsistence Division of the Quartermaster Corps whereby the laboratories of the Bureau of Chemistry, Department of Agriculture, throughout the United States are to be more fully utilized by the Army. Through this arrangement the inspection of food products which requires chemical analysis will be made to a greater extent under the direction of the general supply depots at the source of manufacture. Delays occasioned under the former procedure of having inspection made at the delivery point will thus be avoided. At times cars of greatly needed food products have been held up pending report of analyses. Under the new system such products will have been completely inspected at point of purchase.
>
> The new system will be particularly effective in handling canned milk, putting milk upon the same basis of inspection as canned meat products in large packing houses. Further arrangements have been made whereby, if it develops that any stations of the Department of Agriculture are too remotely situated to afford the proper service, stations will be promptly established by the Bureau of Chemistry to give the required service. This arrangement is another of the steps which the Quartermaster Corps is taking to coördinate all government departments in securing the best supplies and service for the troops.

In the recent reorganization of the Ordnance Department, Lt. Col. W. C. Spruance has been placed in charge of chemicals.

PERSONAL NOTES

Dr. Ernest G. Genoud died at his home in Dorchester, Mass., on October 12, of pneumonia following Spanish influenza. Dr. Genoud was born in Boston, February 23, 1889. After graduation from the Massachusetts Institute of Technology in 1908, he studied abroad, receiving the degree of doctor of engineering at Charlottenburg in 1911. He had become a recognized specialist on fermentation processes and was a member of the staff of A. D. Little, Inc.

The College of the City of New York announces the following additions to the department of chemistry: Henry T. Coles, formerly of Rose Polytechnic Institute, assistant professor of industrial chemistry; Herman C. Cooper, formerly of the University of Syracuse, assistant professor of physical chemistry; Carl R. McCrosky, formerly of Oregon Agricultural College, and T. R. Le Compte, formerly of the Department of Agriculture, as instructors in chemistry.

Mr. Carleton B. Edwards, formerly head of the chemistry department at Guilford College, is now doing chemical engineering work in smokeless powder with E. I. du Pont de Nemours and Co., at the Hopewell Plant, City Point, Va.

Mr. Benton Dales, formerly head of the chemistry department of the University of Nebraska, is now research chemist for the B. F. Goodrich Co., Akron, Ohio.

Miss Jessie E. Minor has resigned her position as associate professor of chemistry at Goucher College to accept a position as chief chemist for the Hammerschlag Paper Mills, Garfield, N. J.

Mr. Seward G. Byam, formerly chemist for the Revere Plant of the United States Rubber Co., Providence, R. I., is now employed as aeronautical chemist at the General Laboratories, Bureau of Aircraft Production, Pittsburgh, Pa.

Mr. Ralph Brown, formerly employed in the laboratory of the Eagle-Picher Lead Co., Joplin, Mo., is now running a small lead smelter for the estate of James Robertson, Galletta, Ont., Canada.

Mr. R. R. Henderson, formerly chief chemist of the Vreeland Chemical Co., has resigned his position with that firm in order to devote his whole time to consulting practice. Mr. Henderson specializes in the development of chemical processes and the application of automatic machinery to chemical productions. His headquarters are at Little Falls, N. J.

Mr. Richard L. Wing, formerly chief chemist for the Holmes Mfg. Co., New Bedford, Mass., is now Engineer, Area "E," U. S. Government Explosives Plant "C," Nitro, West Virginia.

Mr. Paul J. Carlisle, who for the past two years has been engaged in research for the Roessler and Hasslacher Chemical Co., Perth Amboy, N. J., has been transferred to St. Albans, W. Va., and placed in charge of a new department which the company is adding to its plant in that city.

Mr. Arthur P. Harrison, formerly chemist and bacteriologist with the National Soil Improvement Co., Charlottesville, Va., is now supervising the synthetic preparation of certain dye intermediates for the du Pont Dye Works, Wilmington, Del.

Mr. Philip G. Wrightsman, formerly instructor in chemistry at Iowa State College, is now in the Chemical Warfare Service working on toxic gases in the Research Division, American University, Washington, D. C.

Mr. H. M. Freeburn has resigned as assistant engineer of the Pennsylvania State Department of Health to become associated with the engineering staff of Wallace and Tiernan Co., Inc., New York City, manufacturers of chlorine control apparatus and sanitary engineering specialties.

Dr. Arthur M. Pardee has resigned his position as professor of chemistry at Tarkio College, Tarkio, Mo., and has been appointed professor of chemistry at Washington and Jefferson College, Washington, Pa.

Mr. H. L. Walter, formerly of the U. S. Bureau of Chemistry, has been appointed chief chemist of the State Food and Drug Department of Tennessee.

Mr. Harry L. Barnitz, consulting engineer on oxygen and hydrogen, has severed his connection with the International Oxygen Co. and is conducting business under his own name at 617 West 152 St., New York City.

Mr. A. G. Frericks, formerly chief chemist for the Palmer Tire and Rubber Co., St. Joseph, Mich., is now doing chemical inspection work in the Explosives Section of the Ordnance Department.

The Association of British Chemical Manufacturers has elected officers as follows: *President*, The Right Honorable Lord Moulton, K. C. B., G. B. E., etc.; *Chairman*, Mr. Robert Grosvenor Perry, C. B. E.; *Vice Chairman*, The Right Honorable J. W. Wilson, M. P.

Mr. L. S. Munson, who for the past eleven years has been with the Ault and Wiborg Co., Cincinnati, O., has recently accepted the position of assistant superintendent of the Deepwater Point, N. J., plant of the du Pont Dye Works.

L. D. Sale, Los Angeles, Cal., has been named chairman of the chemical, oils, and paints section of the Los Angeles district of Sub-Region No. 14, Region No. 19, of the resources and conversion division of the War Industries Board.

Dr. Walter Taggart has been appointed consulting chemist-at-large for the Ordnance Department.

Mr. Alex H. McDowell, formerly with Wiley and Co., is now chemist at the Ashepoo Fertilizer Works, Charleston, S. C., of the American Agricultural Chemical Co.

Mr. Lawrence C. Stahlbrodt has been appointed by the Pfaudler Co., Rochester, N. Y., to take charge of its publicity department.

Mr. F. W. Bruckmiller, formerly assistant professor of chemistry at the University of Kansas, is now chemist for the Standard Oil Co. (Indiana), at Sugar Creek, Mo.

Mr. C. C. Vogt is on leave of absence from the industrial fellowship on dental supplies of the Lee S. Smith and Son Mfg. Co. in order to engage in gas investigations at the American University Experiment Station.

Professor H. F. Moore, of the Engineering Experiment Station of the University of Illinois, has been appointed by the National Research Council chairman of the committee to investigate the fatigue phenomena of metals.

Mr. S. M. Evans, vice president of the Eagle-Picher Lead Co., with headquarters in N. Y., has been relieved of duty with his company for the duration of the war and is now with the U. S. Fleet Corporation, with headquarters at Philadelphia, as chief statistician.

Dr. C. A. Brautlecht, professor of chemistry in the Florida College for Women, has been called into the Sanitary Corps as First Lieutenant. He is stationed at the Rockefeller Institute for Medical Research in New York City.

Mr. James K. Lawton, formerly chemist with the J. H. Pratt Laboratory, Tampa, Fla., has been commissioned Second Lieutenant in the infantry, United States Army, and assigned for duty with the Chemical Warfare Service, Edgewood Arsenal, Edgewood, Md.

Dr. Frank T. F. Stephenson, past president of the Detroit Section of the AMERICAN CHEMICAL SOCIETY, has been commissioned Captain in the Medical Corps.

Mr. Max L. Towar, formerly of Parke, Davis & Co., Detroit, Mich., is now with the National Aniline Company, of Buffalo.

Mr. Chas. H. Jumper, formerly secretary of the Detroit Section of the AMERICAN CHEMICAL SOCIETY, and chief chemist with the General Motors Co., Detroit, is now connected with the Calco Chemical Co., Bound Brook, N. J.

Mr. S. B. Chadsey, chairman of the Toronto Section of the Society of Chemical Industry and formerly assistant to the general manager of the Massey-Harris Company, has been appointed manager of the Massey-Harris Company's plant at Brantford, Ont.

Mr. G. Hallberg, formerly with the Riordon Pulp and Paper Company, Limited, Hawkesbury, has been appointed chemist at the Mattagami Pulp and Paper Company's sulfite mills at Smooth Rock Falls, Ont.

Mr. Harold B. Gammell, formerly stationed at Indian Head, Md., has been assigned to duty under the inspector of powders, East Coast, as sub-inspector at the plant of the Standard Textile Co., Glens Falls, N. Y. This work is under the Navy in which he enlisted in April 1917.

Mr. Wm. Garratt, formerly chief chemist for the Latrobe Electric Steel Co., Latrobe, Pa., now has a similar position with the Fulton Steel Corporation, Fulton, N. Y.

Mr. James S. Curry for some time supervising chemist for the du Pont Company at Wilmington, Del., died of pneumonia on October 12, 1918.

Mr. W. W. Jones, formerly manager of the New York office of Frederick Stearn and Co., has accepted the appointment of manager of the Essential Oil and Gum Department of the National Aniline and Chemical Co., Inc., 21 Burling Slip, New York.

Mr. Charles Crew has resigned his position with the Central Testing Laboratory and has taken charge of the consulting work on chemical engineering for The Stillwell Laboratories, Inc., New York.

Miss Elvira Weeks, formerly with the New Jersey Zinc Co., Franklin, N. J., is now in the Research Department of the Carborundum Co., Niagara Falls, N. Y.

Mr. Harold W. Baldwin, formerly with the National Aniline and Chemical Co., Inc., Boston, Mass., is now in the Army and doing research work at the American University Experiment Station.

Dr. J. Bishop Tingle, professor of chemistry at McMaster University, Toronto, died on August 6, in Ottawa, Ont. He had been a prominent figure in the scientific world for many years. For three years he was at Johns Hopkins University where he did organic research work and edited sections of the *American Chemical Journal*. Since the outbreak of the war, recognizing the part that chemistry was to play, he had laid special emphasis on training students for laboratory positions in war industries.

In addition to the silver service which was given to Dr. M. C. Whitaker on his retirement from the presidency of the Chemists' Club, an exquisite illuminated memorial, designed by Mr. Edward B. Edwards, has also been presented to him. The center is a Latin text written by Professor McCrea of Columbia University and the border decoration consists of portraits of Gerber, Bacon, Lully, and Paracelsus in the four corners and alchemistic symbols interestingly worked into a decorative design.

Mr. Arthur Given, formerly chief chemist for Morris Herrmann and Company and recently chemical engineer with Stevens-Aylsworth Company, has been appointed First Lieutenant in the Ordnance Department and is stationed at Picatinny Arsenal.

Mr. Edward W. Weiler has given up his position as research chemist for the United States Industrial Alcohol Co., Baltimore, Md., to enter the Chemical Warfare Service.

Mr. B. A Dunbar has recently been made head of the chemistry deparment at the South Dakota State College.

Mr. M. Cannon Sneed, formerly assistant professor of chemistry at the University of Cincinnati, is now head of the division of general and inorganic chemistry at the University of Minnesota.

Professor J. B. Rather, formerly head of the department of agricultural chemistry in the University of Arkansas, has accepted a position as chemist with the Standard Oil Company, New York.

Dr. M. L. Crossley, associate professor and acting head of the department of chemistry at Wesleyan University, Middletown, Conn., has resigned to accept the position of chief chemist for the Calco Chemical Co., Bound Brook, N. J.

In addition to those noted in the February issue of THIS JOURNAL, the following members of the staff of the department of chemistry of the College of the City of New York have gone into war work: Martin Meyer, 2nd Lieutenant, U. S. A.; Benjamin Rayved, Ensign, Paymaster Division; Leon J. Smolen, Nathan Rauch, Moses Chertcoff, Martin Kilpatrick, Hyman Storch, Joseph L. Guinane, Samuel Yachnowitz, Privates, Chemical Warfare Service; Julius Leonard, Alexander Lehrman, Yeomen, U. S. N.

Mr. E. J. Quinn, formerly research chemist at the Montana Agricultural Experiment Station, has accepted an appointment as assistant professor in the department of chemistry at the State College of Agriculture and Mechanic Arts, University of Montana, Bozeman.

Ricketts & Co., Inc., formerly of 80 Maiden Lane, have moved their offices to 280 Madison Avenue. Mr. Charles E. Wagstaffe Bateson, Dr. M. L. Hamlin, and Mr. T. A. Shegog, formerly assistant professor of chemistry and metallurgy at the Royal College of Science, Dublin, and professor of chemistry and metallurgy for the County of Monmouth, are associated with them.

Mr. F. W. Bunyan has resigned his position as testing chemist for the Southern Pacific Railway Company to accept a position as assistant chemist with the Noble Electric Steel Company, Heroult, Shasta Co., Cal.

Mr. H. A. Noyes, research associate in horticultural chemistry and bacteriology at the Purdue Agricultural Experiment Station, has resigned to accept an industrial fellowship with the Mellon Institute, University of Pittsburgh.

Mr. Edward P. Bartlett, formerly assistant professor of chemistry at Pomona College, Claremont, Cal., has been commissioned Captain in the Military Intelligence branch of the Army.

Dr. Arthur L. Day has resigned as director of the Geophysical Laboratory, Carnegie Institution of Washington, to do research work for the Corning Glass Works, Corning, N. Y.

Dr. H. C. McNeil, of the chemical department of the Bureau of Standards, has been appointed professor of chemistry at George Washington University, as successor to Prof. C. E. Munroe, who is giving all his time to the investigation work of the Committee on Explosives of the National Research Council.

Professor Moses Gomberg, professor of organic chemistry at the University of Michigan, has been commissioned Major in the Ordnance Department and is stationed in Washington.

Dr. H. S. Washington, of the Geophysical Laboratory, has been appointed chemical associate to the scientific attachés at the American embassies in Paris and Rome.

Professor M. F. Coolbough, of the department of chemistry, Colorado School of Mines, is in Washington on leave of absence and is engaged in war work at the Bureau of Mines.

Dr. H. M. Loomis, formerly of the Bureau of Chemistry, Department of Agriculture, has been made chief inspector of the sardine canneries of Maine and Massachusetts, for the Food Administration.

Mr. F. C. Teipel, recently associated with Bush, Beach and Gent, Inc., has rejoined Dana and Co., Inc., N. Y., as manager of their chemical department.

Lieutenant Colonel Charles F. Craig, who until recently has been stationed at Fort Leavenworth, Kansas, has been placed in charge of the Yale Army Laboratory School, the new school for bacteriologists and chemists.

Dr. Joseph C. Bock, formerly instructor at Cornell University Medical School, has been appointed professor of physiological chemistry in the school of medicine of Marquette University, Milwaukee.

Dr. F. Mollwo Perkin has been elected president and Mr. H. A. Carwood secretary of an association, which has been organized in England, of chemists engaged in the oil, color, and allied trades.

Mr. Charles L. Raiford, head of the department of chemistry at Oklahoma Agricultural and Mechanical College, Stillwater, Okla., has been elected associate professor of chemistry at the University of Iowa.

Dr. E. B. Spear, professor of inorganic chemistry at the Massachusetts Institute of Technology and consulting expert to the Bureau of Mines, delivered an illustrated lecture on "Some Problems of Gas Warfare" at the Brooklyn Institute of Arts and Sciences on October 19.

INDUSTRIAL NOTES

Alfred I. du Pont, the owner of the Grand Central Palace, N. Y., has announced that, notwithstanding the fact that the Government is to take over the building for the period of the war as a base hospital for the Army and Navy, he intends to proceed with his plans for creating there a center for world commerce after the war in an Allied Industries Corporation.

Japanese manufacturers have well developed their dyestuff industries since the war. They have more than 100 factories and an investment of more than $7,470,000. It is hoped that some plan may be devised whereby they may be able to resist invasion of foreign products after the war.

The Labor Department announces that the chemical industries of Niagara Falls, N. Y., are in great need of women employees. The survey of the plants was made by representatives of various Federal Departments acting under the direction of the Women in Industry Service of the Department of Labor.

American dyestuffs are gaining a hold on the Japanese market, which has heretofore been dominated by German products obtained through neutral countries. This gain is clearly shown by the figures of imports of dyestuffs into Japan for the first quarter of 1918. Japan is now a permanent factor in the manufacture of cotton and silk piece goods and the importance of building up a market there for American dyestuffs cannot be overemphasized.

Reorganizers of the Federal Dyestuff and Chemical Corporation, of Kingsport, Tenn., have decided to call their new company the Union Dyestuff and Chemical Corporation. It is understood that the company anticipates some large orders from the Government for chemicals.

The War Department has awarded a contract to the American Phosphorus Co., Philadelphia, for the construction of a $500,000 phosphorus plant at Fairmont, W. Va.

LIST OF APPLICATIONS MADE TO THE FEDERAL TRADE COMMISSION FOR LICENSES UNDER ENEMY-CONTROLLED PATENTS PURSUANT TO THE "TRADING WITH THE ENEMY ACT"

YEAR	PAT. NO.	PATENTEE	ASSIGNEE	PATENT	APPLICANT
1908	896,807	Karl Dieterich, Helfenberg, Saxony, Germany.	....	Improvement in agar-agar-cascara products and processes of making same.	Reinschild Chemical Co., 47–49 Barclay St., New York City.
1909	943,163	Adolph Schmidt, Dresden, Germany.	Chemische Fabrik Helfenberg, A. G., formerly Eugen Dieterich.	Improvement in agar-agar-cascara products.	Reinschild Chemical Co., 47–49 Barclay St., New York City.
1905	782,739	Emil Fischer, Berlin, Germany.	E. Merck, Darmstadt, Germany.	*C,C*-Dialkylbarbituric acid and process of making same.	Fellows Medical Manufacturing Co., Inc., 26 Christopher St., New York City.
1906	812,554	Alfred Einhorn, Munich, Germany.	Farbwerke vorm. Meister, Lucius & Brüning, Höchst-on-the-Main, Germany.	Alkamin esters of para-aminobenzoic acid.	Fellows Medical Manufacturing Co., Inc., 26 Christopher St., New York City.
1903	718,340	Otto J. Graul, Ludwigshafen-on-the-Rhine, Germany.	Badische Anilin & Soda Fabrik, Ludwigshafen-on-the-Rhine, Germany.	Process of making cyanmethyl derivatives of aromatic amids.	National Aniline & Chemical Co., Inc., 21 Burling Slip, New York City.
1917	1,216,612	Otto Schmidt, Ludwigshafen-on-the-Rhine, Germany.	Badische Anilin & Soda Fabrik, Ludwigshafen-on-the-Rhine, Germany.	Producing soluble tanning agents.	E. C. Klipstein & Sons Co., 644 Greenwich St., New York City.
1916	1,191,480	Otto Schmidt, Ludwigshafen-on-the-Rhine, Germany.	Badische Anilin & Soda Fabrik, Ludwigshafen-on-the-Rhine, Germany.	Tanning.	E. C. Klipstein & Sons Co., 644 Greenwich St., New York City.
1909	943,578	Rudolf Tambach, Ludwigshafen-on-the-Rhine, Germany.	Knoll & Co., Ludwigshafen-on-the-Rhine, Germany.	Digitalis extract.	Merck & Co., 45 Park Pl., New York City.
1907	62,521	Ichthyol Gesellschaft Cordes, Hermanni & Co., Hamburg, Germany.	....	Trade-mark "Ichthyol" for medicated soap.	Takamine Laboratory, Inc., 120 Broadway, New York City.
1907	61,011	Ichthyol Gesellschaft Cordes, Hermanni & Co., Hamburg, Germany.	....	Trade-mark "Ichthyol" for plasters and certain medicinal preparations.	Takamine Laboratory, Inc., 120 Broadway, New York City.
1907	62,603	Ichthyol Gesellschaft Cordes, Hermanni & Co., Hamburg, Germany.	....	Trade-mark "Ichthyol" for medicinal sulfonic acids and their salts.	Takamine Laboratory, Inc., 120 Broadway, New York City.
1906	54,088	Vereinigte Chininfabriken Zimmer & Co. Ges. mit beschrankter Haftung, Frankfort-on-the-Main, Germany.	....	Trade-mark "Euquinine" for derivatives of cinchona alkaloids.	Takamine Laboratory, Inc., 120 Broadway, New York City.

The Pacific Electro Metals Company is now operating a silicon-manganese furnace and will in the very near future be operating another furnace making ferromanganese. Each of these furnaces has a capacity of 3,000 kilowatts. In addition, three 300 kilowatt furnaces are being installed in which ferronickel, ferromolybdenum, ferrochrome, and ferrotungsten will be made as the raw materials are available. To make the plant self-contained and independent of outside sources for electrodes, an electrode plant has been erected and local raw materials have been applied to the manufacture of electrodes. The directors of the company are C. D. Clarke, San Francisco, *President;* J. M. Kroyer, Stockton, Cal., *Vice-President;* Henry Koster, San Francisco, *Treasurer;* C. F. Potter, San Francisco, and J. W. Beckman, San Francisco.

A new chemical firm financed by Des Moines, Iowa, capital has entered the field. It is known as the Consolidated Chemical Products Co., of Alton, Ill.

To encourage the production and distribution of manganese used extensively in production of munitions, steel, and other war supplies, the Railroad Administration has ordered a reduction of about 20 per cent in rates on manganese ore from western producing fields to eastern manufacturing centers.

The Puerto Cortes consulate has been advised by residents that they have discovered and denounced a rich deposit of manganese within 2 miles of the Honduras National Railway. They claim that this ore is mixed with graphite, gold, and copper.

The New Jersey Zinc Company has issued a series of pamphlets explaining the composition and uses of zinc dust, zinc pigments, rolled zinc, spelter and other zinc products, and will send the booklets free to those interested.

The West End Mining Co., San Francisco, is preparing to install equipment and begin the development of potash beds in the Searles Lake district along lines endorsed by the Government.

The Isle of Pines promises to become an important producer of iron, copper, and other ores. Eleven mines have already been located, though only two are being actively developed as yet. The Cuban government is taking a most active interest in the development of these mines.

Kemico, Inc., has incorporated under the laws of Delaware to manufacture dyes, chemicals, and colorings of all kinds; capital, $10,000; incorporators, C. I. Rimlinger, F. A. Armstrong, B. A. Spangler.

Two sulfuric acid plants are to be erected in Pennsylvania, one at Emporium, the other at Mt. Union, under the supervision of the Construction Division of the Army. The estimated cost for both plants is $3,000,000. The Emporium plant will consist of eight units on a site on Driftwood Creek, close to the plants of the Aetna Explosives Company and the Emporium Iron Company. The Mt. Union plant will be erected adjacent to the plant of the Aetna Explosives Company. Twenty acres of land have been purchased at $56 an acre. The contract has been awarded to the Leonard Construction Company. The preparation of all plans and specifications, in addition to the supervision of the work, will be under the direction of the Construction Division.

At Copenhagen, Denmark, there is being held an exhibition of products made from the nettle plant, which, in these times of great shortage of raw material for the textile industry, is of considerable interest. In the department for readymade stuffs are to be found tablecloths, napkins, and towels in most diverse patterns. The nettle cloth is snow white, pliable, and pleasant. The exhibits show that practically all of the material is used, as, in addition to that consumed in making textiles, some is ground for fodder and some used in the paper industry. This is an entirely Danish industry and the people in the different districts are taught how to prepare the nettles for delivery to the factories.

Since 1916 the cane sugar industries around Lake Maracaibo, which formerly produced for local markets, have been exporting large quantities to England and the United States owing to the present high prices and scarcity of sugar.

Linoleum manufacturers have been asked by the Conservation Division of the War Industries Board to cut down the styles from 3 patterns to one and to do away with inlay linoleum. In addition to this they have been asked to cut down their use of chrome.

The large chemical companies manufacturing sulfuric acid and the powder manufacturers who depend upon the American production of sulfur for use in making explosives were considerably disturbed by reports that the Louisiana plant of the Union Sulfur Co., at Lake Charles, had been partly destroyed by a cyclone the latter part of August. Repairs are in progress and the plant will soon be restored to its normal condition.

M. Lechner Co., Manhattan, N. Y., has incorporated to deal in dyes, dyestuffs, powder, oils, etc.; capital, $10,000; incorporators, R. Lechner, A. Schmidt, B. Schneir, 200 Fifth Ave.

John R. Rettig and Co., Stockholm, has started to manufacture the electric-insulating material, micanite.

In order to increase the domestic supply of bromine, the Government had additional brine wells drilled in Michigan early in 1918. A large part of the output is marketed in the form of potassium bromide, sodium bromide, and other salts.

Peach pit and coconut hull charcoal are said to be more efficacious than ordinary charcoal in the soldier's gas mask and the United States has undertaken to furnish the special charcoal to the Allies. A nation-wide campaign for the collecting of this material is in progress.

A process for making a substitute for leather out of cotton is now being used by a company formed for that purpose. Machines have already been designed for making shoe laces, belts, and straps, and it is hoped that material several inches wide may soon be made.

At a recent meeting of the House of Commons a vote on the supplementary estimates for the Board of Trade of £1,000,000 ($4,866,500), the first installment of an advance for the development of the British dye industry, was agreed to. The object of this advance is to establish the dye industry on a sound basis within a reasonable time after the end of the war.

Plans are under consideration by the Solvay Process Co., Syracuse, N. Y., for the construction of a large plant in Grand Rapids, Mich., for the manufacture of picric acid.

The New England Chemical Co., Boston, has been incorporated with a capital of $500,000 to manufacture, export, and deal generally in dyestuffs and chemicals.

An explosion occurred in the chemical plant of the Barrett Manufacturing Co., Philadelphia, on September 17, 1918. Two men were killed and the blaze which followed the explosion threatened at one time the Government munition plant at the Frankford Arsenal.

The so-called Krayseska method, a new means of drying eggs, fruit juice, and blood, has been found worth while in Germany. The drying is done in a large iron cylinder, 5 meters in diameter, in which a pair of large metal wings rotate rapidly, driven by a steam turbine. The fluid is lashed to foam and dried by the aid of a current of hot air which is continually passed through the cylinder. The dried product is in the form of a powder, which will keep for a long time and can be most economically transported.

The Florida Fertilizer Milling Company has been incorporated with a capital of $100,000. The incorporators are F. D. M. Strachan, Geo. F. Armstrong, and Clarence Camp.

Dr. Richard B. Moore of the United States Bureau of Mines has announced that mesothorium is an excellent substitute in many ways for radium. He believes that this substance should be used instead of radium in luminous paints, gun sights, and the dials of watches, compasses, and airplane instruments.

From recent experiments it has been shown that worth while extracts of potash may be obtained from the common wild desert grease-wood shrub growing in Texas.

The American Indian Oil and Gas Co., Poteau, Okla., is to install machinery for the manufacture of carbon from natural gas.

A new fertilizer called tetraphosphate is being manufactured in Italy, which is considered equally as good if not better than superphosphate. It was invented in 1914 by Professor Stoppani, of Bologna, and the process was patented and purchased by an Italian company. Considerable progress has since been made notwithstanding the present difficulties in obtaining the phosphate rock and necessary reagents. From the eleven plants now in operation there is a yearly output of 500,000 quintals and four new plants are under construction.

Extensive phosphate deposits on Nauru or Pleasant Island and Ocean Island, located northwest of New Zealand, are said to be the most valuable deposits of the kind in the world. The quantity of phosphate available is estimated at 500,000,000 tons, and as fertilizer the deposit is said to rival the famous nitrate fields of Chile.

Production of toluene has been commenced by the Hiram Walker and Sons Chemical Co., Walkerville, Canada. The aim of the corporation is to furnish toluene for war purposes and to develop an after-the-war trade in dyes and chemicals.

Swift and Co., Chicago, have let a contract for the construction of a salad oil plant at Charlotte, N. C., costing $75,000.

Fire occurred on September 21 at the plant of the Ames Chemical Laboratory, Glens Falls, N. Y., manufacturers of nitrate of silver.

On October 5 fire completely destroyed the Charleston Chemical Plant, at Bello, near Charleston, W. Va. The plant had been operated by the Government for several months.

The natural steam and water of the "soffioni" of the volcanic area of Tuscany contain large quantities of boric acid and are being used as a source of the acid which is produced about 99 per cent pure. The acid is treated with sodium carbonate to obtain borax which is manufactured in the form of crystals and powder. Ammonium carbonate is also manufactured and research work is being done to determine the radioactivity of the gases and the possibility of the separation of helium which is also present.

The Bureau of Mines has requested an elimination of wheat flour from the manufacture of high explosives other than "permissibles." This flour has been used in making dynamite and other explosives employed in mining and engineering operations. It is estimated that this will save more than 16,000 barrels.

Several factories are being built for extracting wax from candelilla weed, which grows in great profusion upon many thousands of acres of land bordering the Rio Grande in Texas. An important feature of this industry is that it has recently been discovered that the ash residue contains probably the highest percentage of potash of any known species of vegetation. The dried bagasse of the candelilla is used for fuel in the factory, and from the ashes, it is claimed, enough potash may be obtained to pay the entire expense of operating.

The Medical Research Board of the Division of Military Aeronautics, after recent experiments with lenses for air pilots' glasses, has announced that it has been able to effect the casting of certain substances in thin sheets which, while not glass, can be used as such and may afford a practical substitute for goggles. Thin sheets of the material have been produced which can even be ground and polished. The substance is hard and non-inflammable and insures practically a non-shatterable lens for the protection of the pilots' eyes.

The manufacture of calcum carbide is being resumed near Germiston, South Africa, as the difficulty of producing a suitable electrode has been overcome. It is expected that after a few changes are made 2$^1/_2$ tons of carbide will be produced per 24 hrs.

The British Minister of Munitions has issued an order prohibiting the purchase, sale, or delivery of any radioactive substances, luminous bodies or ores without a permit.

A ruling of the War Trade Board restricts the importation into the United States of dyewoods and vegetable dye extracts as to shipments made after Oct. 10.

The Southern Acid and Sulfur Co., East St. Louis, Ill., is planning the development of sulfur properties and the manufacture of sulfuric acid at Port Arthur and Texarkana, Texas.

The Porterite Efficiency Products Corporation, New York City, manufacturers of paints, oils, and varnishes, has been incorporated with a capital of $500,000. The incorporators are W. J. Eldredge, P. J. Dobson, and J. A. Martin.

As a result of the increasing lemon crop, a plant has been built at Corona, Cal., for manufacturing citric acid and also for making and experimenting with other products.

The Hercules Powder Company, Landing, N. J., has recently engaged about fifty women from various colleges throughout the United States to act in the capacity of chemists.

The business of the New England Paint, Oil, and Varnish Co., Everett, Mass., has been purchased by the du Pont Company.

As the result of a terrific explosion of T N T at the T. A. Gillespie Loading Company's plant at Morgan, N. J., nearly one hundred persons were killed and 325 of the 700 buildings were destroyed.

The volcanic island of Santorini, in the Aegean Sea, produces a natural cement called "portselana," which, mixed in certain proportions with lime and sand, makes an excellent substitute for the best cement. The high price of imported cement has brought this product into prominence.

The gathering of moss in Sweden is now organized on a large scale. About 50,000 school children will be occupied in this work during the next three months and it is estimated that they can gather 17,500 tons of moss, to be used as cattle feed.

GOVERNMENT PUBLICATIONS

By R. S. McBride, Bureau of Standards, Washington

NOTICE—Publications for which price is indicated can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. Other publications can usually be supplied from the Bureau or Department from which they originate. Commerce Reports are received by all large libraries and may be consulted there, or single numbers can be secured by application to the Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington. The regular subscription rate for these Commerce Reports mailed daily is $2.50 per year, payable in advance, to the Superintendent of Documents.

PUBLIC HEALTH SERVICE

Official Control of Antipneumococcus and Antimeningococcus Serums. G. W. McCoy. Public Health Reports 33, 1313–1316. Issued August 9.

GEOLOGICAL SURVEY

Gravel Deposits of the Caddo Gap and De Queen Quadrangles, Arkansas. H. D. Miser and A. H. Purdue. Bulletin 690–B. From Contributions to Economic Geology, 1918, Part I. 15 pp. Published June 14.

New Determinations of Carbon Dioxide in Water of the Gulf of Mexico. R. C. Wells. Professional Paper 120–A, from Shorter Contributions to General Geology, 1918. 16 pp. Published June 20.

The Upper Chitina Valley, Alaska. F. H. Moffit. With a Description of the Igneous Rocks by R. M. Overbeck. Bulletin 675. 82 pp. Paper, 25 cents.

The only minerals yet found in this district that may be of possible economic importance are copper, gold, and molybdenum. No copper ore has been mined nor is any likely to be mined in the near future, for practically no work has been done on the copper deposits except the assessment work necessary to hold a few claims. The present price of copper, however, should stimulate the search for that metal in this district.

A little gold has been produced, but it is doubtful if the quantity recovered has been sufficient to pay more than a small part of the cost of production.

A vein of molybdenite is reported by a prospector who spent part of the summer of 1915 in the upper Chitina Valley. The vein, which is about 8 miles from the lower end of the largest of the Canyon Creek glaciers, is in granite and is reported to be 8 feet wide and to consist of quartz and molybdenite. The molybdenite forms a solid vein, 12 in. thick, between the quartz and the hanging wall and occurs in stringers and bunches through the quartz and in disseminated flakes in the quartz. There is no timber near the property, and the best source of supply would be Young Creek, which is separated from Canyon Creek by a low, flat divide that could be easily traversed. Sleds afford the only method of transportation now available in winter, and any ore produced from the vein will have to be brought out over the glacier ice to Canyon and Young Creeks and carried thence to the railroad at McCarthy.

Some Manganese Deposits in Madison County, Montana. J. T. Pardee. Bulletin 690–F. Being a Separate from Contributions to Economic Geology, 1918, Part I, pp. 131–143. Published July 8, 1918.

Platinum and Allied Metals in 1917. J. M. Hill. Being a Separate from Mineral Resources of the United States, 1917, Part I, pp. 11–21. Published June 21, 1918.

Crude platinum was produced in Alaska, California, Oregon, and Washington in 1917. Buyers and refiners report purchases of 605 ounces from producers in these States, which, at the average price ($90 an ounce), would have a value of $54,450. Incomplete returns from placer mines that produce crude platinum indicate that the production in 1917 fell off about 100 ounces from that of 1916, when it was 710 ounces. In view of the high prices for crude platinum in 1917 this decrease is rather difficult to understand, but part of it may be due to the fact that some of the miners held their platinum for higher prices.

Dealers and refiners reported sales in 1917 of 72,186 ounces of secondary platinum metals derived from refining scrap and sweeps. The figures that make up this total probably represent some duplication, as the same metal may be handled as scrap several times in a year. The large increase in the sales of scrap metals indicate clearly that, owing to the greatly decreased imports of crude platinum and the high prices paid for scrap, much attention was given to the collection and refining of all kinds of scrap containing platinum metals.

The imports of platinum and allied metals for consumption in 1917, exclusive of the 21,000 ounces of Russian platinum received in December, which do not appear in the reports of the Bureau of Foreign and Domestic Commerce for 1917, were about 57 per cent of the imports in 1916 and about 25 per cent of the pre-war imports.

The quoted price of refined platinum in the New York market was $80 to $82 a troy ounce in January 1917, but it increased to $102 to $105 in February and remained nearly stationary throughout the year. The average price for the year was $102.80 a Troy ounce.

After the War Department had commandeered all crude and refined platinum on March 2, 1918, a maximum price of $105 an ounce for all imports was set by the War Industries Board.

Refined palladium was quoted at $70 to $85 a troy ounce at the beginning of 1917, but prices advanced continuously throughout the year, being $115 to $125 for the period from August to November and reaching a maximum of $130 to $135 the last of December. Refined iridium was apparently sold only by special bargaining, and no very definite information is available concerning its price. Apparently $110 was the nominal quotation in January, but sales in the last months of 1917 are said to have been made at $180 to $185 an ounce.

Quicksilver Deposits of the Phoenix Mountains, Arizona. F. C. Schrader. Bulletin 690–D. Being a Separate from Contributions to Economic Geology, 1918, Part I, pp. 95–109. Published June 26, 1918.

Cadmium in 1917. C. E. Siebenthal. Being a Separate from Mineral Resources of the United States, 1917, Part I, pp. 49–53. Published July 12, 1918.

Cadmium was first produced in the United States by the Grasselli Chemical Company in 1917. One by one other companies began the recovery of cadmium until there are now six producing companies, as follows: American Smelting & Refining Co.; Grasselli Chemical Co.; Krebs Pigment & Chemical Co.; Mammoth Copper Mining Co.; Midland Chemical Co.; and United States Smelting, Refining & Mining Co. As cadmium residue resulting from the production of electrolytic spelter is accumulating at several plants there will doubtless be other producers before long.

Cadmium is produced in the United States in two forms—metallic cadmium and the pigment, cadmium sulfide. The domestic production of metallic cadmium in 1907 was nearly sufficient to supply the home demand, a fact shown by the small imports for that year, but in 1908 the quantity of cadmium imported was almost doubled, and in 1909–1912 the imports were back at the figures that prevailed before cadmium had been produced in the United States. Since 1912, however, the domestic production has made great strides, and as a result the imports of cadmium are again small. As the imports came largely from Germany they have been practically stopped for the last four years.

Complete statistics of the exports of cadmium are not available, but it is known that domestic cadmium has been largely exported during the war. According to the Bureau of Foreign and Domestic Commerce the following quantities of cadmium were exported through the port of New York in the last quarter of 1916: In October, 33,244 pounds, valued at $55,259; in November, 4,900 pounds, valued at $5,100; and in December, 1,044 pounds, valued at $1,530. Of the exports in October, 23,210 pounds went to France, 9,984 pounds to Italy, and 50 pounds to Dutch Guiana.

Unrefined cadmium in cadmium residues has also been exported, as noted above.

The price of stick cadmium throughout the first half of 1917 was listed in retail lots as nominal at $1.50 a pound. During the last half of the year the quotations remained practically stationary at $1.40 to $1.75 a pound. The average price for 1917 as calculated from sales was $1.47 a pound, as compared with an average of $1.56 a pound in 1916. The price in London during the first four months of 1917 was 7s. $7^{1}/_{2}$d. ($1.75) a pound; during the next five months it was 8s. $1^{1}/_{2}$d. ($1.90) a pound, and for the remainder of the year it was from 7s. 3d. to 7s. $7^{1}/_{2}$d. ($1.70 to $1.75) a pound.

The average selling price of cadmium sulfide in the United States in 1917 was $1.41 a pound, as compared with $1.26 a pound in 1916.

The value of the output of cadmium in the United States in 1917, calculated at the average selling price, was $305,097, as compared with $210,931 in 1916, and the value of the cadmium sulfide produced was $70,939, as against $27,942 in 1916.

The total value of the output of metallic cadmium in the United States since the beginning of production in 1907 is $830,673 and of cadmium sulfide $151,389, both together equal to nearly a million dollars.

Manganese and Manganiferous Ores in 1916. D. F. Hewett. Being a Separate from Mineral Resources of the United States, 1916, Part I, pp. 731–756. Published July 18, 1918.

As an indication of the condition of the domestic manganese industry during 1916 it may be said that probably in no other mineral industry has there been the same inducement for change in source of supply, price, and manner of utilization. The continued elimination of established foreign sources of manganese ore and ferromanganese has caused the country to depend almost entirely on the ore deposits in Brazil. As prices of ore and ferromanganese more than doubled within the year, there has been strong incentive to utilize less desirable domestic supplies of ore. As a result, domestic production of each grade of ore in 1916 was nearly three times that of 1915. Although this is still only a small part of the country's needs as expressed in terms of manganese metal, the production is much larger than many competent observers thought possible several years ago.

The domestic shipments of manganese ore in 1916 were 26,997 gross tons; of ferruginous manganese ore, 176,130 tons; and of manganiferous iron ore, 372,673 tons. Most of this material is used in the iron and steel industries.

Gems and Precious Stones in 1916. W. T. Schaller. Being a Separate from Mineral Resources of the United States, 1916, Part II, pp. 887–899. Published June 27, 1918.

Talc and Soapstone in 1917. J. S. Diller. Being a Separate from Mineral Resources of the United States, 1917, Part II, pp. 81–84. Published July 12, 1918.

The sales of talc in 1917 amounted to 198,613 tons, valued at $1,889,672, a gain, as compared with 1916, of nearly 3 per cent in quantity and of more than 7 per cent in value. Thirty-seven producers reported to the Geological Survey, of whom 7 were in California, 6 in Georgia, 1 each in Maryland, Massachusetts, and New Jersey, 4 in New York, 6 in North Carolina, 2 in Pennsylvania, 5 in Vermont, and 4 in Virginia.

The highest average priced talc, including that which was cut for gas tips, pencils, and insulators, was sold from Georgia, North Carolina, and Vermont, and the highest prices ranged from $50 to $200 a ton. The lowest priced material was sold as rough talc (crude) at prices ranging from $3 to $8 a ton, or on an average of $5.58 a ton. Its value was greatly increased by grinding and ranged, when ground, according to quality, from $5 to $20 a ton, although the general average was only $9.11 a ton.

Magnesite in 1917. C. G. Yale and R. W. Stone. Being a Separate from Mineral Resources of the United States, 1917, Part II, pp. 63–69. Published July 19, 1918.

Until 1917 practically all the domestic magnesite was produced in the State of California, but in that year the newly developed deposits in Stevens County, Wash., yielded nearly one-third of the domestic output. Formerly this county imported from 250,000 to 350,000 tons of magnesite (stated in terms of crude material), mostly from Austria-Hungary and Greece. Practically all the California output was consumed on the Pacific Coast, mainly as a digester for wood pulp in paper mills, but to some extent as plastic material for flooring, plaster, and cement. The freight rate to eastern points from California was prohibitive, in view of the cheapness of the imported material. Since the opening of the war, however, and especially since the United States became involved in it, the importation from Austria-Hungary has ceased, and, except for a comparatively small quantity derived mostly from Greece and Canada, the country has been compelled to rely upon the domestic product. The natural result of this condition has been renewed activity in the larger mines and the opening and development of numerous new properties.

At the beginning of 1917 the crystalline magnesite from Washington was new on the market and untried. It so quickly proved its value that the market consumed all that the new quarries could produce. Toward the end of the year, however, embargo against shipments into the freight-congested district east of Chicago and north of Ohio and Potomac Rivers began to delay and limit shipments from both California and Washington, for many of the plants that make refractory products from magnesite are east of Chicago. In spite of this embargo the continued demand caused an increase of more than 100 per cent in production in 1917 over 1916, the previous record year.

The crude magnesite produced and sold or treated in the United States in 1917 amounted to 316,838 short tons, valued at $2,899,818, as compared with 154,974 tons, valued at $1,393,693, in 1916. In 1917 California produced 211,663 tons, valued at $2,116,630, and Washington 105,175 tons, valued at $783,188. California's increase in quantity over the production of 1916 was 37 per cent. Washington began production in December 1916, 715 tons being shipped by the end of the year.

The Nesson Anticline, Williams County, North Dakota. A. J. Collier. Bulletin 691–G, from contributions to Economic Geology, 1918, Part II. 6 pp. Published August 15. As it is generally recognized that the highest parts or crests of anticlines or arches in the rocks are the most likely places to find accumulations of natural gas, it would seem advisable that one or more wells be drilled about four miles east or southeast of the Nelson well in search of a larger gas flow.

The Santo Tomas Cannel Coal, Webb County, Texas. G. H. Ashley. Bulletin 691–I, from contributions to Economic Geology, 1918, Part II. 19 pp. Published July 25.

Gold and Silver in 1916. (General Report.) H. D. McCaskey and J. P. Dunlop. Separate from Mineral Resources of the United States, 1916, Part I, pp. 679–721. Published May 7.

Chromite in 1917. J. S. Diller. Separate from Mineral Resources of the United States, 1917, Part I, pp. 37–47. Published August 8.

The domestic production in 1917, so far as may be judged from reports already received by the Geological Survey, was 43,725 long tons. It came mainly from California, where the output was more than 36,700 long tons. Oregon ranks second, with a production of about 6,700 long tons. Alaska produced nearly 1,000 tons, and the remainder, less than 300 long tons, came from Washington, Maryland, and North Carolina. As a considerable number of supposed producers have not yet reported, it is possible that the total production may turn out finally to be somewhat greater. It seems probable that the total domestic production in 1917 was about 3,000 tons less than in 1916. If so, the decline deserves special consideration in view of the constantly increasing demand.

To discover, if possible, the causes of decline in the production of chromite in 1917, the United States Geological Survey sent out a questionnaire to all the chrome producers on its list, asking for statements of the maximum possible production of the mine during the last quarter of 1917 and the actual shipments of chromite from the mine during the same period, the difference being the deficiency in production due to one or more causes, of which the following may be noted: Bad weather, poor roads in winter, lack of funds, lack of shipping facilities, especially lack of cars as the result of the freight embargo, low prices, and uncertainty of market, particularly for low-grade ore. The last two are the most potent causes affecting small producers.

The price of 40 per cent chromite at the beginning of 1917 was $15 a ton, that is, 37$^1/_2$ cents a unit of chromic oxide, but at the end of the year the price had been raised to 70 cents a unit, or $28 a ton. The actual price reported to the Geological Survey ranged from $10 to $50 a ton and the average price of the ore sold during the year by producers was a little more than $24 a ton. Early in 1918 the price for 40 per cent ore reached 85 cents a unit ($34 a ton). The impending crisis resulting from lack of ships to import the ore needed for war purposes has impelled the principal consumer, the Electrometallurgical Co., of New York, to advance prices greatly in the hope of increasing domestic production.

The block chrome ore sold on the Pacific Coast in the summer of 1917 ranged in composition from 30 to 55 per cent chromic oxide and the average composition was 42 per cent.

Of the chromite mined and sold in the United States in 1917, 22 per cent of the total quantity contained from 45 to 50 per cent of chromic oxide, 32 per cent contained from 41 to 45 per cent of chromic oxide, 36 per cent contained from 38 to 41 per cent of chromic oxide, and 10 per cent contained from 30 to 38 per cent of chromic oxide.

Of the ore marketed on the Pacific Coast in 1917 nearly nine-tenths contained 38 per cent or more of chromic oxide and fell within the price of $1.25 a unit now offered. Important contracts for chromite ranging from 30 to 35 per cent chromic oxide have recently been signed, but the prices for that grade of ore have not yet greatly increased. It is hoped, however, that the large consumers of chrome ore for refractory purposes, as well as for ferrochrome, may further stabilize prices not only by adopting this scale of prices but by establishing a corresponding minimum price for ore below the grade of 38 per cent chromic oxide and thus contribute greatly to the increased production of low-grade ores and incidentally aid in promoting concentration.

The most striking feature of the imports in 1917 is the great decrease in the total from 115,945 long tons in 1916 to 72,063 long tons in 1917. This decrease is due wholly to restricted shipping facilities on account of the war and affects particularly imports from South Africa and New Caledonia, which require long overseas transportation. On the other hand, the imports from Canada have greatly increased and those from Guatemala appear for the first time. Only 17 tons have come from Cuba, but recent developments indicate that Cuba and also Brazil will soon be large contributors to our needs of chromite.

The measure of normal annual consumption of chromite for all the various uses before the war may best be expressed by the sum of domestic production and imports in 1913, about 65,000 long tons. On account of the greatly augmented demands of war conditions it has been estimated by the committee on mineral imports and exports of the Shipping and War Trade Boards that the needs of the United States in 1918 will be equivalent to about 130,000 long tons of 50 per cent ore, of which 67,500 tons will be needed for ferrochrome, 40,000 tons for making bichromates and other chemicals for tanning, etc., and 22,500 tons for refractory purposes.

Gold, Silver, Copper, Lead, and Zinc in the Eastern States in 1917. J. M. Hill. Separate from Mineral Resources of the United States, 1917, Part I. 7 pp. Published July 29.

Slate in 1917. G. F. Loughlin. Separate from Mineral Resources of the United States, 1917, Part II. 17 pp. Published July 30.

The total value of the domestic slate sold in 1917—$5,749,966—was an increase of nearly 8 per cent over that for 1916, which was an equal increase over the value in 1915. This increase was common to all the slate products recorded but was most marked in slate for "other uses." The increase in value, however, is in marked contrast to the prevailing decrease in quantity of the different products sold and only indicates the degree to which prices have been advanced to offset increased cost of production.

Feldspar in 1917. F. J. Katz. Separate from Mineral Resources of the United States, 1917, Part II. 5 pp. Published August 7.

The marketed production of domestic feldspar in 1917 was the largest ever recorded. It was an increase of nearly 7 per per cent in quantity as compared with 1916, 35 per cent as compared with 1915, and 5 per cent as compared with 1914. As reported prior to 1916, the values of the yearly production have expressed the combined sales of crude and ground feldspar and have, therefore, shown wider fluctuation than the quantities because of changes from year to year in the proportions sold as crude or ground. The value of the combined production in 1913 was the largest in the decade, and the production in 1915 dropped almost to the low level of 1908 and 1909. The industry rallied markedly in 1916 and 1917, making productions substantially as large as in the best years.

The average price for feldspar sold crude in 1917 was $3.40 a long ton, as compared with $3.34 in 1916 and $3.46 in 1915, the range in prices during 1917 reported to the United States Geological Survey being from $2 to $7 a long ton. The average price of ground feldspar in 1917 was $10.15 a short ton, compared with $9.30 in 1916 and $8.33 in 1915, the range in 1917 in prices reported to the Geological Survey being from $5.70 to $17 a ton.

Of the total marketed production about 70 per cent was sold crude and 30 per cent ground in 1917, compared with 63 per cent and 37 per cent, respectively, in 1916, and 69 per cent and 31 per cent in 1915.

Sand-Lime Brick in 1917. J. Middleton. Separate from Mineral Resources of the United States, 1917, Part II. 1 p. Published August 20.

The sand-lime brick industry, contrary to indications at the beginning of the year, showed decrease in both output and value in 1917 compared with 1916. The causes for the decrease in output are not difficult to find. The principal cause was the general decrease in building activities; the scarcity of labor, likewise a general condition, was another cause, and transportation conditions may be cited as a third reason for this decline. The increase in the cost of production was reflected in the increased cost to the consumer of the principal product—common brick—of $1.11 per thousand, compared with 1916. Notwithstanding the decrease in the value of the sand-lime brick marketed in 1917 the value in that year was the greatest in the history of the industry with the exception of 1916.

The decrease in the quantity of sand-lime brick sold in 1917 compared with 1916 was 39,798,000 brick, or nearly 18 per cent, but the decrease in value was only $53,743, or 4 per cent.

Gems and Precious Stones in 1917. W. T. SCHALLER. Separate from Mineral Resources of the United States, 1917, Part II. 23 pp. Published July 29. This article contains a very complete glossary of gem names.

Mica in 1917. W. T. SCHALLER. Separate from Mineral Resources of the United States, 1917, Part II. 12 pp. Published July 29.

Although the total value of all mica produced and sold in the United States in 1917, as reported to the United States Geological Survey, was the highest on record, the total quantity was smaller than that for any preceding year since 1908, with the exception of 1912. This was due in part to the fact that a good deal of the scrap mica mined was not sold.

The prices paid for mica in 1917 continued, with minor fluctuations, to increase throughout the year. The prices paid for domestic mica in the South in 1917 were from 10 to 20 per cent higher than the prices for similar mica in 1916. The greatest increase was for the smaller sizes, especially for the $1^1/_2$ by 2, 2 by 2, and 2 by 3 in. The largest sizes showed no increase in price.

The average price per pound of sheet mica produced in 1917 was 58 cents, a price lower than for either 1916 (61 cents) or 1915 (68 cents), but higher than for any other preceding year. A very large amount of punch or washer mica was produced in 1917, and as this averaged only 5 cents a pound it materially lowered the average value of all sheet mica with which it was combined.

Graphite in 1917. H. G. FERGUSON. Separate from Mineral Resources of the United States, 1917, Part II. 29 pp. Published July 26.

The increase in metal manufacture incident to the progress of the war has brought a greatly increased demand for crucible graphite, and the amount of graphite suitable for crucible use, both domestic and imported, consumed during the year was approximately 30,000 short tons, as against 13,500 short tons in 1913. The domestic production has responded to the greater demand and during the last three years has shown a steady increase.

Estimates furnished by the producers of crystalline graphite show that out of the total sales of 10,584,080 lbs., 6,816,913 lbs., valued at $982,336, or about 64 per cent by weight and 90 per cent by value of the total, was flake graphite containing from 80 to 90 per cent graphitic carbon, in large part suitable for crucible use. The remainder, 3,767,167 lbs., valued at $112,062, was dust or low-grade flake probably averaging under 50 per cent graphitic carbon. The proportion of flake produced is higher than in previous years, owing in part to improved milling methods, whereby a larger proportion of the graphite was saved as flake, and in part to the fact that because of the freight embargo during the latter part of the year such shipments as the Alabama producers were able to make consisted mainly of the better grade material.

The production of amorphous graphite during 1917 was 8,301 tons, valued at $73,481, as compared with 2,622 tons, valued at $20,723 in 1916. As amorphous graphite is not suitable for use in crucible manufacture, war conditions have no increased the demand for it to so marked a degree as for crystalline graphite. Moreover, the production of flake graphite for crucible use yields a large amount of dust as a by-product, and this dust is available for practically all uses.

Graphite is manufactured chiefly by the International Acheson Graphite Co., which utilizes electric power generated at Niagara Falls. The output has increased greatly in recent years and now forms an important element in the country's graphite supply. The bulk graphite is made either from anthracite or from petroleum coke and is utilized mainly in lubricants and paints and for foundry facings, boiler-scale preventives, and battery fillers.

Besides the graphite products that enter into competition with natural graphite, there are a large number for which artificial graphite is particularly adapted. Chief among these is graphite electrodes, the demand for which has greatly increased during the last three years on account of the remarkable growth in certain electrochemical industries.

Domestic flake graphite brought slightly higher prices in 1917 than in 1916. The prices received at the mines for the best grades ranged from 12 to 18 cents a pound for No. 1 flake, according to its grade; from 6 to 10 cents a pound for Nos. 2 and 3; and from half a cent to 5 cents a pound for dust. Flake graphite containing 90 per cent or more of graphitic carbon sold for considerably higher prices than the usual product containing 85 per cent carbon or less.

Salt, Bromine, and Calcium Chloride in 1917. R. W. STONE. Separate from Mineral Resources of the United States, 1917, Part II. 12 pp. Published August 10.

Salt is so abundant and so widely distributed in the United States that the industry can meet domestic requirements in spite of unfavorable conditions. At some plants in 1917 there was shortage of labor, difficulty in obtaining fuel, and an inadequate supply of freight cars, yet the total production for the country was a notable increase over that of 1916. The salt produced and sold in the United States in 1917 was 6,978,177 short tons, valued at $19,940,442, an increase of 9.7 per cent in quantity and 46.1 per cent in value over the production of 1916.

From the itemized figures in the table it is determined that the increase in production of manufactured or evaporated salt in 1917 was 1.1 per cent, of brine salt 13.8 per cent, and of rock salt 17.3 per cent. The much larger increase in rock salt is a measure for the readiness with which the production of salt by mining can be expanded in comparison with the production by evaporating brine.

The average price increased 33 per cent and was $2.86 per ton in 1917, as compared with $2.14 in 1916. This great increase in price was caused by higher wages paid for labor and higher cost of fuel and an other supplies.

The quantity of bromine marketed in 1917 increased nearly 23 per cent over the production in 1916.

The production of bromine was retarded in 1917 by steadily falling price and increasing cost of production, by railroad freight congestion, by embargo on shipments which hindered the movement of salt, by shortage of labor and fuel at some plants, by needed repairs, and by the extremely cold weather in December.

The wholesale price of bulk bromine in New York was 25 to 35 cents a pound in 1913, 30 to 35 cents from January to August 1914, and 40 to 50 cents from September to December 1914.

The following table shows a large increase in consumption and a very large increase in value of calcium chloride in 1917:

CALCIUM CHLORIDE PRODUCED AND MARKETED IN THE UNITED STATES, 1915–1917

YEAR	Quantity Short Tons	Average Price per Ton
1915	20,535	$ 6.37
1916	27,709	8.12
1917	30,503	14.80

Sulfur, Pyrites, and Sulfuric Acid. P. S. SMITH. Separate from Mineral Resources of the United States, 1917, Part II. 43 pp. Published July 10.

Although precise statistics are not given, it may be said that the domestic production in 1917 was nearly 50 per cent greater than in 1916—a year during which several hundred per cent more sulfur was produced than in any year before the war.

According to reports received from the Bureau of Foreign and Domestic Commerce, the quantity of crude sulfur or brimstone exported from the United States in 1917 was 152,833 tons, valued at $3,504,661. This was the greatest export of sulfur by this country in a single year, exceeding by nearly 20 per cent the previous record quantity exported in 1916. The exports in 1917 exceeded by more than 70 per cent the exports in 1913, which may be taken as fairly representative of normal conditions immediately before the war.

Up to 1900 the annual domestic production of sulfur was relatively insignificant and about 175,000 long tons of sulfur were imported each year. With the commercial development of the deposit in Louisiana the importation of sulfur suddenly decreased, and in 1907 the imports amounted to only about 20,000 tons. Since that year up to and including 1916 the imports of sulfur each year have been between 20,000 and 30,000 long tons. In 1917, however, owing to the restrictions imposed by certain of the foreign governments, the difficulty of obtaining ships, and the quantity of domestic sulfur available, less than 1,000 tons of foreign sulfur were received in this country.

The domestic production of pyrites in 1917 was 462,662 long tons, valued at $2,485,435, an increase of about 39,000 long tons in quantity and of about $520,000 in value, as compared with the production in 1916. The consumption of pyritic ore in 1917—that is, the domestic production plus imports—amounted to about 1,430,000 long tons and was about 240,000 long tons less than the consumption in 1916. This decrease was largely attributable to the great falling off in imports.

In addition to the pyritic ores reported here, returns from manufacturers of sulfuric acid show that 708,500 long tons of domestic copper-bearing sulfide ores, 147,531 long tons of foreign copper-bearing sulfide ores, 594,100 long tons of domestic zinc-bearing sulfide ores, and 152,911 long tons of foreign zinc-bearing sulfide ores were treated in 1917 for their sulfur as well as for their metallic content.

The production of sulfuric acid in 1917 was nearly twice as great as the production in 1913, which may be taken as a normal pre-war year. The expansion in the industry to meet the conditions imposed by the war had been begun in 1916, so that the increase in 1917 over 1916 was much less than the increase in 1916 over 1915.

The production of sulfuric acid in 1917 expressed in terms of 50° Bé. was 5,967,551 short tons valued at $71,505,536, to which must be added 759,039 short tons of acids of strengths higher than 66° Bé., which cannot be converted for purposes of calculation into acid of 50° Bé., valued at $16,034,645. The total value of all the sulfuric acid produced in 1917 was therefore $87,540,181. This production shows an increase in 1917 over 1916 of the acid expressed as of 50° Bé. of more than 325,000 short tons in quantity and of about $8,800,000 in value and an increase in stronger acids of more than 315,000 short tons in quantity and $5,225,000 in value. The value of the total production of sulfuric acid in 1917 was therefore more than $14,000,000 greater than the value in 1916.

The totals given above include by-product acid—that is, acid produced at copper and zinc smelters. The production of acids from this source in 1917, expressed in terms of 60° acid, was 1,336,209 short tons, valued at $14,516,104, to which must be added 119,048 short tons of acids of strengths higher than 66° Bé., which can not be calculated in terms of acid of 60° Bé., valued at $2,374,441. None of the stronger acids are reported to have been produced at copper smelters, and no 50° acid was reported to have been produced at either the copper or the zinc smelters.

BUREAU OF CENSUS

Chemicals and Allied Industries. Census of Manufacturers, 1914. 85 pp. One of a series of bulletins being issued by the Bureau, presenting statistics of industries, concerning which inquiries were made at quinquennial census of manufacturers in 1914. Statistics are presented in three sections: Summary and analysis, giving general data compiled for industry; special statistics relating to materials, products, and methods of manufacture; and State tables, giving comparative summary, by States, for 1904, 1909 and 1914, and detailed statistics for industry, by States, 1914.

Leather Industry. Census of Manufacturers, 1914. 63 pp.

Wool Manufacturers. Census of Manufacturers, 1914. 48 pp.

Patent and Proprietary Medicines and Compounds and Druggists' Preparations. 18 pp.

BUREAU OF MINES

Bibliography of Petroleum and Allied Substances, 1915. E. H. BURROUGHS. Bulletin 149. 111 pp. Paper, 15 cents.

Oil Storage Tanks and Reservoirs. With a brief discussion of losses of oil in storage and methods of prevention. C. P. BOWIE. Bulletin 155. 68 pp. Paper, 25 cents.

Mining and Concentration of Carnotite Ores. K. L. KITHIL AND J. A. DAVIS. Bulletin 103. 77 pp. Paper, 25 cents. Prepared under a coöperative agreement with the National Radium Institute.

Initial Priming Substances for High Explosives. G. B. TAYLOR AND W. C. COPE. Technical Paper 162. 20 pp. Paper, 5 cents.

The Use of Permissible Explosives in the Coal Mines of Illinois. J. R. FLEMING AND J. W. KOSTER. Bulletin 137. 103 pp. Paper, 20 cents. This report was prepared under a coöperative agreement with the Illinois State Geological Survey and the engineering experiment station of the University of Illinois.

Metal-Mine Accidents in the United States during the Calendar Year 1916. A. H. FAY. Technical Paper 202. 78 pp. Paper, 10 cents.

Quarry Accidents in the United States during the Calendar Year 1916. A. H. FAY. Technical Paper 193. 55 pp. Paper, 10 cents.

Siliceous Dust in Relation to Pulmonary Disease Among Miners in the Joplin District, Missouri. E. HIGGINS, A. J. LANZA, F. B. LANEY AND G. S. RICE. Bulletin 132. 108 pp. Paper, 25 cents.

Recovery of Gasoline from Natural Gas by Compression and Refrigeration. W. P. DYKEMA. Bulletin 151. 117 pp. Paper, 25 cents. "This report treats of the compression and refrigeration process for the recovery of gasoline from natural gas from the viewpoint of the practical engineer and businessman. Conditions of actual operation and the equipment in use are cited and described so that operators, and others interested, can compare the variations in methods of treating natural gas for its gasoline content in the different fields and also the conditions encountered and the features that control the methods used."

The Quick Determination of Incombustible Matter in Coal and Rock-Dust Mixtures in Mines. A. C. FIELDNER, W. A. SELVIG AND F. D. OSGOOD. Technical Paper 144. 29 pp. Paper, 10 cents. "An investigation of the specific-gravity method of determining the percentage of rock dust, ash, or dry incombustible in mixtures of coal and rock dust such as are found in the entries and rooms of mines showed that this method was rapid and sufficiently accurate for use in controlling the application of rock dust in mines."

Effects of Moisture on the Spontaneous Heating of Stored Coal. S. H. KATZ AND H. C. PORTER. Technical Paper 172. 19 pp. Paper, 5 cents. "The only recommendation of practical import to be made as a result of the matters considered in this paper is to prevent the segregation of the fine coal in building a pile for shortage. This has been proposed before as a means of reducing the danger of spontaneous combustion. The consideration of moisture now gives it further support."

Weights of Various Coals. S. B. FLAGG. Technical Paper 184. 7 pp. "A study of the foregoing table indicates that heavier weights may be expected for coals of high fixed carbon content than for those of low. Increased ash content seems to lower the unit weight. It is also true, in general, that the coals high in moisture are lighter than those low in moisture and the younger coals are lighter than the older coals."

Use of the Interferometer in Gas Analysis. F. M. SIEBERT AND W. C. HARPSTER. Technical Paper 185. 12 pp. Paper, 5 cents. This paper describes the outcome of some of the investigations made by the Bureau of Mines in connection with work on mine gases and natural gas.

Physiological Effect of Different Gases on Man. G. A. BURRELL. Large chart unnumbered. This chart shows the pertinent physical properties and easily recognized characteristics of mine gases in a form that can readily be understood by miners.

Temperature-Viscosity Relations in the Ternary System $CaO–Al_2O_3–SiO_2$. A. L. FEILD AND P. H. ROYSTER. Technical Paper 189. 36 pp. Paper, 5 cents.

Analyses of Mine and Car Samples of Coal Collected in the Fiscal Years 1913 to 1916. A. C. FIELDNER, H. I. SMITH, J. W. PAUL AND SAMUEL SANFORD. Bulletin 123. 478 pp. Paper, 50 cents.

Measuring the Temperature of Gases in Boiler Settings. H. KREISINGER AND J. F. BARKLEY. Bulletin 145. 72 pp. Paper, 15 cents. "This book is one of a series of publications being issued by the Bureau of Mines for the purpose of disseminating information in regard to the methods by which the fuels in this country may be used most efficiently."

A Convenient Multiple-Unit Calorimeter Installation. J. D. DAVIS AND E. L. WALLACE. Technical Paper 91. 48 pp. Paper, 15 cents.

The Diffusion of Oxygen through Stored Coal. S. H. KATZ. Technical Paper 170. 47 pp. Paper, 10 cents.

Slag Viscosity Tables for Blast-Furnace Work. A. L. FIELD AND P. H. ROYSTER. Technical Paper 187. 38 pp. Paper, 5 cents. The purpose of this report is to make available to the operator the results of the slag-viscosity measurements made in the laboratories of the Bureau. This information, if used intelligently, should help the blast-furnace operator to reduce losses caused by off-grade pig iron; to improve fuel economy; to promote operating efficiency; and to extend present-day practice to meet the increasing need of smelting lean and complex ores.

Methane Accumulations from Interrupted Ventilation. H. I. SMITH AND R. J. HAMON. Technical Paper 190. 46 pp. Paper, 10 cents. This report was prepared under a coöperative agreement with the Illinois State Geological Survey and the Engineering Experiment Station of the University of Illinois.

BUREAU OF STANDARDS

Wave Lengths in the Red and Infra-Red Spectra of Iron, Cobalt, and Nickel Arcs. W. F. MEGGERS AND C. C. KIESS. Scientific Paper 324. 14 pp. Paper, 5 cents.

The Properties and Testing of Optical Instruments. Circular 27. 2nd Ed. 41 pp. Paper, 10 cents. In recent years many types of optical instruments have been developed and have come into more or less common use. At the same time, a great deal has been written in the English language on optical subjects, but there is no general discussion of optical instruments in nontechnical language for the benefit of the average person who owns, for example, opera glasses or a camera. The primary purpose of this circular is to correct this deficiency by giving a simple description of the principal features of optical instruments, to explain the causes and correctness of various imperfections, and to indicate methods of testing for the presence of imperfections which mar the ideal performance of optical instruments. This information, for the most part, can be found in various textbooks and treatises on optical subjects, but the fact that it is inaccessible to many people, because it is widely scattered and generally couched in mathematical language, is the reason for this presentation. This circular should not be mistaken for a complete treatise on optical instruments. It is intended first of all to serve the public who use optical instruments but who have had little opportunity to study the physical theory of such instruments.

DEPARTMENT OF AGRICULTURE

Commercial Bordeaux Mixtures: How to Calculate their Values. E. WALLACE AND L. H. EVANS. Farmers' Bulletin 994. 11 pp.

Tests of the Absorption and Penetration of Coal Tar and Creosote in Longleaf Pine. C. H. TEESDALE AND J. D. McLEAN. Department Bulletin 607. 43 pp. Paper, 15 cents. Published June 6.

Digestibility of Some Seed Oils. A. D. HOLMES. Department Bulletin 687. 20 pp. Paper, 5 cents. Published June 28. This bulletin records studies of the digestibility of corn oil, soy-bean oil, sunflower-seed oil, Japanese mustard-seed oil, rapeseed oil, and charlock oil. It is primarily of interest to students and investigators of food problems.

Articles from the Journal of Agricultural Research

Influence of Gypsum upon the Solubility of Potash in Soils. P. R. McMILLER. 14, 61–66 (July 1).

Mineral Content of Southern Poultry Feeds and Mineral Requirement of Growing Fowls. B. F. KAUPP. 14, 125–134 (July 15).

A Comparative Study of Salt Requirements for Young and for Mature Buckwheat Plants in Solution Cultures. J. W. SHIVE AND W. H. MARTIN. 14, 151–175 (July 22).

Composition and Digestibility of Sudan-Grass Hay. W. G. GAESSLER AND A. C. McCANDLISH. 14, 176–185 (July 22).

Soil Reaction and the Growth of Azotobacter. P. L. GAINEY. 14, 265–271 (August 12).

Effect of Different Oxygen Pressures on the Carbohydrate Metabolism of the Sweet Potato. H. HASSELBRING. 14, 273–284 (August 12).

COMMERCE REPORTS—AUGUST 1918

Special efforts are being made in Australia to increase the production of industrial denatured alcohol by diverting plants engaged in the manufacture of potable spirits. (P. 441)

Over one hundred dyestuff factories are in operation in Japan. In order to protect them in the future, a high tariff is suggested. (P. 454)

Owing to the cutting off of foreign supplies of salt, steps are being taken in Holland to develop extensive salt beds, the existence of which has long been known. (P. 499)

In Mexico, it is proposed to manufacture alcohol and a cattle food, from "sotol," a plant which grows wild in unlimited quantities. (P. 503)

Large deposits of lignite of good quality have been discovered in Greece, where they will be especially valuable owing to lack of coal deposits. (Pp. 512 and 667–71)

The Canadian Research Council has urged the formation of "industrial guilds," to be made up of firms or companies in the same or allied industries, for the purpose of conducting **research** laboratories for the benefit of the members of the guild. In some cases government aid, in the form of grants or laboratory space, may be furnished. (P. 580)

The syndicate which controls the **sulfur** industry of Sicily, has been granted an extension of 12 years, in view of the present unsettled condition and the increased competition of American, Japanese and African sulfur. (P. 623)

Plans are being made for extensive development of the **iron ore** deposits of Brazil at the close of the war. (P. 636)

Owing to the shortage of **adhesives** in Germany, glue is being extracted from bones by treatment with sulfur dioxide, removal of fat by benzene extraction, and then boiling the bones under pressure. Various vegetable juices are also being used in the manufacture of adhesives. (P. 680)

Detonation caps are being made in Sweden with an explosive containing copper, and no mercury. (P. 685 and 808)

Arrangements have been made for the first installment of £1,000,000 on the British loan for the development of the **dye** industry, in order to promote the manufacture of those dyes which are essential, but cannot now be produced on a commercial basis. (P. 705)

A plant is to be erected in Colon for the manufacture of **coconut oil** and **palm oil**, and **soap**, and by-products. (P. 709)

A new process for the production of **salt, magnesium salts, sodium sulfate, iodine** and **bromine**, from seawater, is being installed in Norway. (P. 820)

Bids received in Brazil for the erection of **caustic soda plants**, all specified the electrolytic process, except one which proposes to use the Solvay process. (P. 828)

SPECIAL SUPPLEMENTS ISSUED DURING THE MONTH

Denmark—4*a*
France—5*c*
Italy—8*b*
Spain—15*b*
Liverpool and Sheffield—19*f*
Bradford, England—19*g*
Scotland—19*h*
Canada—23*c*
French West Indies—28*b*
Honduras—31*a*
China—52*f* and *g*

STATISTICS OF EXPORTS TO THE UNITED STATES

Mexico—712
Antimony
Arsenic
Bones
Copper
Gold
Silver
Cottonseed cake
Guayule rubber
Hides
Horn
Ixtle fiber
Lead
Mercury
Sarsaparilla
Tin
Candelilla wax
Zinc ore
Denmark—Sup. 4*a*
Chalk
Diamonds
Flint pebbles
Hides
Paper
Porcelain
Rennet

France—Sup. 5*c*
Dye extracts
Photographic paper
Antimony sulfide
Hides
Liverpool—Sup. 19*f*
Bones
Wool grease
Crude gums
Hides
Rubber
Ferromanganese
Palm oil
Rapeseed oil
Fish oil
Paper stock
Ammonium sulfate
Ammonium chloride
Cochineal
Cutch
Gum tragasol
Sodium silicate
Sodium sulfate
China
Artificial silk
Tin

China—Sup. 52*f*
Antimony
Beeswax
Albumen
Cantharides
Camphor
Aniline dyes
Indigo
Gall nuts
Musk
Rhubarb
Sodium benzoate
Tumeric
Hides
Pig iron
Tungsten ore
Bean oil
Castor oil
Cottonseed oil
Peanut oil
Rapeseed oil
Wood oil
Linseed
Sesame
Zinc ore

BOOK REVIEWS

Sulfuric Acid Handbook. By THOMAS J. SULLIVAN. McGraw-Hill Book Company, Inc., New York City, 1918. Price, $2.50, net.

This book owes its chief value to the fact that it contains the unusually complete set of sulfuric acid tables adopted by the Manufacturing Chemists' Association of the U. S. A.

These tables are indispensable in working out problems connected with the manufacture and use of sulfuric acid, and placed together in a convenient form, fill a long-felt want.

J. B. F. HERRESHOFF

Treatise on Applied Analytical Chemistry. By VITTORIO VILLAVECCHIA AND OTHERS. Translated by THOMAS H. POPE. Pp. 475. P. Blakiston's Son & Co., Philadelphia, Pa. 1918. Price, $6.00.

The author of this book has endeavored to present those subjects which have to do with the purchase of raw materials for manufacturing processes. He has also given attention to the analysis of finished products from the standpoint of impurities and adulterations. The book is well arranged and the subjects are presented in a very pleasing manner. It is a commendable volume and should be of value to those interested in the problems of analytical chemistry.

ALLEN ROGERS

Cellulose. An Outline of the Chemistry of the Structural Elements of Plants. By CROSS AND BEVAN. New Impression with Supplement. 348 pp. with 14 plates. Longmans, Green & Co., New York and London, 1918. Price, $4.50.

This is a reprint of the third edition of this classical work which is familiar to all students of cellulose chemistry. The new impression is extended, however, by a supplementary chapter, pp. 311–331, which contains brief paragraphs on pure cellulose, ester anhydrides, reactions of decomposition, physical properties and lignocellulose, while the summary of technical progress since the edition of 1916, is compressed into less than two pages. This is the more to be regretted since the authors state that owing to "the persistent international complications" they have not been able to complete the records which would justify publishing a No. 4 of their series of Researches on Cellulose. In view of the colossal importance which cellulose and its compounds have acquired as war materials, and the noteworthy special applications of paper to war purposes, it is unfortunate that the authors have been unable to bring the subject more nearly up to date.

A. D. LITTLE

The Chemist's Pocket Manual. By RICHARD K. MEADE. 3rd Ed. 530 pp. The Chemical Publishing Company, Easton, Pa., 1918. Price, $3.50.

The author's extensive experience as an engineer and chemist has enabled him to produce a book which should appeal particularly to chemical engineers, works chemists, and superintendents. It differs from other manuals in its practical character. The customary lengthy tables of the properties of inorganic and organic compounds are condensed and the space saved is devoted to matter on fuels and combustion, electricity, mechanics, steam, steam engines and boilers, hydraulics, power transmission, elevators and conveyors. There are a number of useful conversion tables for analytical chemists and a suggestive article on graphic methods for saving calculation. Methods for standardizing weights and calibrating glassware are described.

The last half of the book is taken up by a description of the methods used in the examination of iron, copper, lead, zinc ores, etc., the analysis of iron, steel, alloys, coal, flue gases, clay, lubricating oils, asphalts, soap, mixed paint, fertilizers, water, and Portland cement. In the reviewer's opinion a better selection of methods, both practical and accurate, could scarcely be made. At the end of each part there is an excellent bibliography of the more important magazine articles and books.

The manual is seriously marred by the number of errors. Even a casual examination will disclose quite a few. In the section on mineralogy the proofroom eluders "carnalite, proutsite, pyroxine" may be found. The newspaper atrocity "analine" is discovered on p. 310. "Sulfuric anhydried" appears on p. 205. Sadtler is misspelled Sartler on p. 260. Mohr is Moh on p. 261. One year has 265.24 days on p. 10. The atomic weights of 1917 are used, but the table is titled 1916 on p. 28. Many other errors might be cited.

By this time the reader's confidence in the reliability of the tables is somewhat shaken. To investigate this point the reviewer examined carefully three of the tables. The first of these, the table of logarithms, has two mistakes in the logarithms corresponding to the numbers 110 and 540. The second, the table of molecular weights on pp. 32–35, has eight incorrect formulas. The extinct symbols Al_2Cl_6, $Fe_2Cl_6.K_6Fe_2(CN)_{12}$ are used in this table, whereas the modern ones are listed in the table of reagents on p. 303. The third table, factors on pp. 36–41, contains a number of slight errors. The factors NH_4Cl to NH_3, $BaSO_4$ to SO_3, $Zn_2P_2O_7$ to Zn are seriously in error.

The reagents used in analysis on p. 303 might preferably be made up to a concentration bearing some relation to the molecular weight, as described in A. A. Noyes' "Qualitative Analysis," instead of a haphazard percentage basis. Methyl red is missed from the table of indicators.

In the directions for the determination of the specific gravity of liquids with a pycnometer, the bottle is immersed in water a "little above or below" the standard temperature. The pycnometer is removed as soon as its thermometer shows the proper temperature. This procedure can scarcely give accurate results, since the only guarantee that the temperature of the liquid in the pycnometer is uniform is to have a thermometer in the bath as well as in the bottle, and both thermometers must register the identical temperature before the pycnometer can be removed for weighing.

The book is of handy size, is free from advertising matter, and is well printed on strong paper. It should be in the hands of every chemical engineer and analyst.

A. C. Langmuir

Chemical French. An Introduction to the Study of French Chemical Literature. By Maurice L. Dolt, Ph.D., Professor of Chemistry in the North Dakota Agricultural College. viii + 398 pp. The Chemical Publishing Co., Easton, Pa., 1918. Price, $3.00.

Whether or not chemistry was once a French science, in later times its language has had a decided German accent. Nowadays, however, our interest in French chemists and French chemistry is happily increasing and this book is opportunely timed. It is a companion volume to the well known *Chemical German* of Professor Phillips, being similarly arranged, printed and bound.

French does not present so many new words to the speaker of English as does German, but it is full of troublesome idioms; these the author, who had his birth and early education in France, is well equipped to handle.

Part I consists of four exercises reviewing in chemical language the essentials of French grammar, and of twenty exercises covering the various fields of chemistry. At the head of each is a little vocabulary of new words and phrases occurring in the exercise. Part II comprises classic selections from the French journals, such as that of Pasteur on racemic acid and Moissan on fluorine. The book concludes with a useful table of irregular verbs and a dependable vocabulary of about 5500 terms (which, however, by no means includes all the words that appear in the text).

Chemical French has been carefully prepared and is excellently adapted to its purpose. It will no doubt meet with a cordial reception.

Austin M. Patterson

The Science and Practice of Photography. By John R. Roebuck, Assistant Professor of Physics, University of Wisconsin. D. Appleton & Co., New York, 1918. Price, $2.00.

The sub-title of this book is "An Elementary Textbook of Scientific Theory and a Laboratory Manual" and for the purposes of a class textbook the sharp division between theory and practice thus indicated is perhaps well adapted. The first part, on general theory, consists of the following chapters: Historical Development, Properties of the Gelatin Dry Plate—Exposure and Development, Properties of the Gelatin Dry Plate—Color Sensitiveness, Latent Image Theories, Negative Defects, Positive Processes, Lenses, Color Photography, Good Pictures, with an appendix on Plate Speed Numbers and Development. The second part consists of a Laboratory Manual of exercises for students, taking them through the principal operations and processes; also appendices on apparatus, chemicals, record slips, and photometers.

The book has the outstanding merit of putting the crux of photographic science in the forefront of the argument. This is of course the dependence of the density and character of the negative upon exposure and development, and bound up with this, the relationship of subject, negative, and positive. It is of interest to industrial chemists that two of their number, Hurter and Driffield, were the first to eliminate non-essentials here, to give acceptable definitions of such photographic quantities as density and contrast, and to standardize their measurement. The principles which they derived, and their mathematical and graphic exposition of these, have formed the basis of most subsequent quantitative work.

This has indeed shown that these principles are limiting ones, completely true only under simplified conditions, and actually subject to many deviations in the denser detail of practice. It is, however, their great merit that they discerned an essential reference framework through the fog of practical variations. The author's account of these fundamental matters, in the second chapter, is adequate and lucid. One may venture a hope, rather than a criticism, that a future edition will show an even more extended application of the characteristic curve, for example, in connection with intensification and reduction methods, for positive processes, and also for color sensitizing and color photography. Without some illustration of the influence of color (or wave length) upon the form and gradation of the characteristic curve, the sensitizing curves given are apt to be misleading.

The chemical side of photographic processes receives a less satisfactory treatment. Equations are given somewhat baldly, without any reference to mass action, to reversibility, or other elements of the mechanism of the reactions. In the equation as printed for wet plate development,

$$FeSO. + AgBr = Ag + Fe(SO_4)Br,$$

the ferric bromo-sulfate is surely a questionable species, while the part played by restraining organic acids is not indicated. The treatment of development and organic developers seems rather brusque in a work emphasizing the desirability of scientific foundations, failing which, the process of development becomes only a subject of empirical rules or individual guess-work.

The chapter on the latent image stands out favorably by contrast. It is an excellent and concise piece of work in which the author concludes in favor of the colloid silver theory. It may then be suggested that the chemical aspect of the book would be strengthened if this occasion were used to bring forward the basic principles of colloid chemistry as central to photographic processes. A sufficient claim for an elementary statement will be allowed on considering such facts as these. The modifications of silver bromide described by Stas and others are chiefly colloidal changes due to interrelated adsorption and subdivision. Practically all photographic images are colloidal, their physical texture and color, as well as their chemical reactivity and stability, largely depending upon control of the colloid condition. And virtually all photographic processes are carried out in or upon a colloid medium.

These criticisms must be understood as made from the standpoint of the photographic chemist. As an introduction to photography, the book as a whole strikes one as very readable, well balanced, and admirably adapted to its purpose as a class textbook. This is assisted in no small measure by the well chosen experiments of the Laboratory Manual.

There are some minor errata and misstatements requiring correction. Jean Servias Stas was an eminent Belgian chemist, not a "famous German." H Cl, incorrectly typed H C I on p. 15, is not a desirable acid in gelatino-bromide emulsions. Dr. Scheffer's name is misspelt, pp. 68 and 107, and in the index. Under the carbon process, the alkaline chromates are given as sensitizers, which is misleading, since it is only as dichromates (or bichromates) that sensitizing is effected. Also, the coloring matters used are pigments, not dyestuffs as stated, which are only used to shade them. And in the article on wet collodion in the Laboratory Manual there is no explicit statement of the necessity of saturating the silver sensitizing bath with silver iodide.

The book is well printed on non-glossy paper, with numerous clear illustrations, and has a good index. The footnote advices that articles such and such may be obtained from firms so and so of Berlin, München, Dresden, etc., seem somewhat superfluous at this date.

S. E. SHEPPARD

The American Fertilizer Handbook for 1918. Edited by JOHN D. TOLL. 11th Annual Edition. Ware Brothers Company, Philadelphia, 1918. Price, $1.50.

The American Fertilizer Handbook has become a valuable reference book in the fertilizer industry, and should be found very valuable to anyone connected with this industry. It is classified in the following sections: Fertilizer Materials, Directory of Allied Industries, Phosphate Rock, Fertilizer Machinery, Fertilizer Brokers, Chemists and Engineers, Cottonseed Oil Mills and Machinery, Packers and Renderers.

The first hundred pages are devoted to matters of general interest to the fertilizer industry, giving the officers of the National Fertilizer Association, The Southern Fertilizer Association, Chemical Alliance Incorporated, location of the agricultural experiment stations and the officials of these various stations.

There is also an interesting table showing the fertilizers and tonnages by States.

This is followed by the Fertilizer Materials Statistics which is a very complete and interesting review of the fertilizer materials market, statistics of the production, imports, consumption, and prices of fertilizer materials for several years.

The Phosphate Rock, Sulfur, and Potash articles are very complete and show clearly the status of these materials up to 1918.

The Fertilizer Manufacturers Directory is a well arranged directory of the fertilizer manufacturers arranged by States.

The Directory of the Allied Fertilizer Trades is a buyers' guide to the fertilizer trade.

The Phosphate Rock section includes a treatise on the production of phosphate rock in 1916 by R. W. Stone, United States Geological Survey, Washington, and also gives a complete list of the phosphate mining companies, together with their addresses.

The Fertilizer Machinery section should be valuable to fertilizer manufacturers interested in new construction, equipment and supplies.

The Fertilizer Materials section is merely an advertisement of the companies handling fertilizer materials.

The Brokers Section is also a list of fertilizer brokers.

The Chemists and Engineers is a section covering advertisements by various chemists, assayers, engineers, constructors, lead burners, samplers, etc.

The Cottonseed Oil Machinery section covers in a commercial way the cottonseed oil and meal situation together with statistics. There is also in this section an interesting and very instructive article on the composition of cottonseed by Thomas C. Law, Atlanta, Ga.

The last section in the book, entitled Packers and Renderers, deals with the western animal ammonia market from May 1, 1917, to April 30, 1918. It also has charts showing the market fluctuations on high-grade tankage and blood. This section also has the directory of packing houses and rendering plants.

The book as a whole is a commercial book, a valuable addition as a reference book to anyone who desires information in regard to the fertilizer industry.

J. E. BRECKENRIDGE

Van Nostrand's Chemical Annual. Edited by JOHN C. OLSEN, A.M., Ph.D., Professor of Chemistry, Cooper Union, N. Y., and MAXIMILIAN P. MATTHIAS, Ch.E., Lieutenant, Ordnance Dept., U. S. R., Assistant Editor. Fourth issue. 778 pp. D. Van Nostrand Co., New York, 1918. Price, $3.00.

When a chemical book has gone through four editions, the approval of the profession which has made this possible testifies more emphatically to its merit than it is possible for any reviewer to do. In this case, therefore, the work of the latter can be confined to the pleasant task of approving of the public's discernment and of calling attention to the advances made in the present over former editions.

The standard tables have, of course, been revised and extended in accordance with the latest information obtainable, making use therein of much of the data published by the Bureau of Standards. The new matter includes tables on the physical constants of the radioactive elements, critical data of gases, relative hardness of the elements, the calibration of glass vessels, indicators for volumetric analysis, weight of dry air at different temperatures and pressures, properties of the wrought copper alloys, specific gravity standards, refractometer readings and density of cane sugar solutions, composition of sea water, density and volume of pure water, reduction of weighings to vacuo, pressure of saturated aqueous vapor, weights and measures, capacities of tanks, values of electrical, mechanical, and heat units, conversion of Centigrade to Fahrenheit degrees, freezing mixtures and freezing point of brines, latent heat of vaporization, and the composition and heating value of natural gas.

Directions are given for using logarithms and the slide rule. The section on Stoichiometry has been revised and explanations of the use of the various tables have been inserted throughout the book. A feature of this issue as of others is a complete list of the more important American and foreign books which have appeared since the third issue of the Annual in 1913. The frontispiece of this issue consists of an excellent recent likeness in sepia of Professor Ira Remsen.

RICHARD K. MEADE

Sir Wm. Ramsay as a Scientist and Man. By T. A. CHAUDHURI, Professor of Chemistry, Edward College, Pabna, with introduction by PANCHANAN NEOGI, Government College, Rajshahi. ix + 66 pp. Butterworth and Company, London and Calcutta, 1918. Price, 1/8 net.

This is an exquisite, short but accurate, oriental biography of a man, who not only interpreted, but added much to our technical knowledge of Nature. Students could profitably be directed to read this booked monograph not alone for information, but as an illustration of delightful literary style. It is "an estimate of the sublime lesson of the life and life-work of the British savant within a small compass."

CHARLES BASKERVILLE

NEW PUBLICATIONS

By Clara M. Guppy, Librarian, Mellon Institute of Industrial Research, Pittsburgh

Alloys: Introduction a l'Etude des alliages. W. Broniewsky. Price, 18 fr. Delagrave, Paris.

Analysis: Course of Instruction in the Qualitative Chemical Analysis of Inorganic Substances. A. A. Noyes. 7th Ed. 8vo. 124 pp. Price, $1.50. The Macmillan Co., New York.

Chemistry: Senior Chemistry. G. H. Bailey and H. W. Bauser. 2nd Ed. 8vo. 526 pp. Price, 5s. University Tutorial Press, London.

Color in Relation to Chemical Constitution. E. R. Watson. 8vo. 197 pp. Price, $4.00. Longmans, Green & Co., New York.

Conservation of Food Energy. H. P. Armsby. 12mo. 65 pp. Price, $0.75. W. B. Saunders Co., Philadelphia.

Electric Motors and Control Systems: A Treatise on Electric Traction Motors and Their Control. A. T. Dover. 8vo. 388 pp. Price, 16s. Sir Isaac Pitman & Sons, New York.

Engineering Drawing. T. E. French. 2nd Ed. 8vo. 329 pp. Price, $2.50. McGraw-Hill Co., New York.

Farm Engines and How to Run Them. J. H. Stephenson. 12mo. 252 pp. Price, $1.00. F. J. Drake & Co., Chicago.

Machine Design: Elements of Machine Design. H. L. Nachman. 8vo. Price, 9s. 6d. Chapman & Hall, London.

Mechanism: Principles of Mechanism. W. H. James and M. C. Mackenzie. 8vo. Price, 7s. Chapman & Hall, London.

Metallurgists and Chemists' Handbook: A Reference Book of Tables and Data for the Student and Metallurgist. D. M. Liddell. 2nd Ed. 16mo. 656 pp. Price, $4.00. McGraw-Hill Co., New York.

Metals: Chemical Combination Among Metals. Michele Giua and Clara Giua-Lollini. Translated by G. W. Robinson. 8vo. 341 pp. Price, $4.50. P. Blakiston's Son & Co., Philadelphia.

Metals: Les Metaux. Leurs conditions d'emploi dans l'industrie moderne. Jean Oertle. Price, 10 fr. Librarie Aeronautique, Paris.

Petroleum, Asphalt and Natural Gas. Kansas City Testing Laboratory. 12mo. 248 pp. Price, $2.00. The Author, 1013 Grant Ave., Kansas City, Mo.

Pocket-Book for Mechanical Engineers. D. A. Low. 16mo. 740 pp. Price, $3.00. Longmans, Green & Co., New York.

Rural Water Supplies and Their Purification. A. C. Houston. 8vo. 151 pp. Price, 7s. 6d. Bale, Sons and Danielssohn, London.

Steel: Fabrication de l'acier. H. Noble. 2nd Ed. 632 pp. Price, 25 fr. H. Dunod et E. Pinat, Paris.

Steel: Trempe, Recuit, Cementation et Conditions d'emploi des aciers. L. Grenet. Price, 20 fr. Ch. Beranger, Paris.

Synthetic Dyestuffs and the Intermediate Products from Which They are Derived. J. C. Cain and J. F. Thorpe. 4th Ed. 8vo. 440 pp. Price, 10s. Charles Griffin & Co., London.

Testing, Fault Localization, and General Hints for Wiremen. J. Wright. New Ed. 18mo. 88 pp. · Price, 1s. 6d. Constable & Co., London.

Zinc Industry. E. A. Smith. 8vo. 223 pp. Price, $3.50. Longmans, Green & Co., New York.

RECENT JOURNAL ARTICLES

Alizarin. J. F. Springer. *Color Trade Journal*, Vol. 3 (1918), No. 3, pp. 326–333.

Automatic Shell Heat-Treating Furnaces. W. J. Harris. *Iron Age*, Vol. 102 (1918), No. 10, pp. 565–568.

Bactericidal Efficiency of Soap Solutions in Power Laundry. H. G. Elledge and W. E. McBride. *American Journal of Public Health*, Vol. 8 (1918), No. 7, pp. 494–498.

Benzo Fast Scarlets. C. S. Wehrly. *Color Trade Journal*, Vol. 3 (1918), No. 3, pp. 323–325.

Blast-Furnace Charge at the Bunker Hill Smeltery. C. T. Rice. *Engineering and Mining Journal*, Vol. 106 (1918), No. 10, pp. 436–438.

Boiler Plates: A Cause of Failure in Boiler Plates; Effect of Grain Growth; Alteration of Crystalline Structure by Mechanical Deformation; Some Remedies. Walter Rosenhain and D. Hanson. *The Iron Age*, Vol. 102 (1918), No. 11, pp. 632–636.

Coal Storage in Large Quantities: Methods, Equipment and Typical Installations. H. J. Edsall. *Industrial Management*, Vol. 56 (1918), No. 3, pp. 193–200.

Condensing Quicksilver from Furnace Gases. L. H. Duschak and C. N. Schuette. *Mining and Scientific Press*, Vol. 117 (1918), No. 10, pp. 315–323.

Conveyors. R. S. Lewis. *Mining and Scientific Press*, Vol. 117 (1918), No. 11, pp. 349–355.

Copper Refining: Recovery of Selenium and Tellurium in Copper Refining. M. H. Merriss and H. T. Binder. *Engineering and Mining Journal*, Vol. 106 (1918), No. 10, pp. 443–445.

Correcting Air Volume for Blowing: the Adjustment of Air Supply to a Blast Furnace is Governed Accurately by a New Constant-Volume Corrector, Independent of Temperature, Barometer, and Humidity. L. C. Loewenstein. *The Iron Trade Review*, Vol. 63 (1918), No. 11, pp. 603–610.

Cottrell Processes of Electric Precipitation, with Especial Regard to the Application to the Recovery of Potash as a By-Product. J. S. Grasty. *Manufacturers Record*, Vol. 74 (1918), No. 12, pp. 70–72.

Dyeing: Use of Organic Dyestuffs in the Preparation of Color Lakes. Barrington de Puyster. *Color Trade Journal*, Vol. 3 (1918), No. 3, pp. 320–322.

Dyeing of Feathers and Furs. R. W. Smith. *Color Trade Journal*, Vol. 3 (1918), No. 3, pp. 304–310.

Electric Brass Melting: Present Status of Electric Brass Melting. H. M. St. John. *Chemical and Metallurgical Engineering*, Vol. 19 (1918), No. 6, pp. 321–328.

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MARKET REPORT—OCTOBER, 1918

WHOLESALE PRICES PREVAILING IN THE NEW YORK MARKET ON OCTOBER 19, 1918

INORGANIC CHEMICALS

Acetate of Lime	100 Lbs.	nominal		
Alum, ammonia, lump	100 Lbs.	7.00		
Aluminum Sulfate, (iron free)	Lb.	4	@	5
Ammonium Carbonate, domestic	Lb.	nominal		
Ammonium Chloride, white	Lb.	19	@	20
Aqua Ammonia, 26°, drums	Lb.	nominal		
Arsenic, white	Lb.	9¼	@	17
Barium Chloride	Ton	75.00	@	90.00
Barium Nitrate	Lb.	12	@	14
Barytes, prime white, foreign	Ton	30.00	@	35.00
Bleaching Powder, 35 per cent	Lb.	4½	@	5
Blue Vitriol	Lb.	9¼	@	9¾
Borax, crystals, in bags	Lb.	7¼	@	10¼
Boric Acid, powdered crystals	Lb.	7¾	@	8¾
Brimstone, crude, domestic	Long Ton	nominal		
Bromine, technical, bulk	Lb.	75	@	
Calcium Chloride, lump, 70 to 75% fused	Ton	20.00	@	22.00
Caustic Soda, 76 per cent	100 Lbs.	4.40	@	4.50
Chalk, light precipitated	Lb.	4¾	@	5
China Clay, imported	Ton	20.00	@	30.00
Feldspar	Ton	8.00	@	15.00
Fuller's Earth, foreign, powdered	Ton	nominal		
Fuller's Earth, domestic	Ton	20.00	@	30.00
Glauber's Salt, in bbls	100 Lbs.	2.10	@	3.00
Green Vitriol, bulk	100 Lbs.	2.00	@	2.25
Hydrochloric Acid, commercial	Lb.	C. P. nominal		
Iodine, resublimed	Lb.	4.25	@	4.30
Lead Acetate, white crystals	Lb.	17	@	18
Lead Nitrate	Lb.	C. P. 85		
Litharge, American	Lb.	14	@	15
Lithium Carbonate	Lb.	1.50		
Magnesium Carbonate, U. S. P.	Lb.	20	@	30
Magnesite, "Calcined"	Ton	60.00	@	65.00
Nitric Acid, 40°	Lb.	7¾		
Nitric Acid, 42°	Lb.	8½		
Phosphoric Acid, 48/50%	Lb.	7½	@	9
Phosphorus, yellow	Lb.	1.10	@	1.15
Plaster of Paris	Bbl.	2.00	@	2.50
Potassium Bichromate	Lb.	44	@	46
Potassium Bromide, granular	Lb.	1.25	@	1.30
Potassium Carbonate, calcined, 80 @ 85%	Lb.	35	@	
Potassium Chlorate, crystals, spot	Lb.	40	@	41
Potassium Cyanide, bulk, 98–99 per cent	Lb.	nominal		
Potassium Hydroxide, 88 @ 92%	Lb.	60	@	70
Potassium Iodide, bulk	Lb.	3.75	@	4.00
Potassium Nitrate	Lb.	27	@	30
Potassium Permanganate, bulk, U. S. P.	Lb.	1.85	@	2.00
Quicksilver, flask	75 Lbs.	125.00	@	130.00
Red Lead, American, dry	100 Lbs.	11.25	@	11.50
Salt Cake, glass makers'	Ton	17.50	@	22.00
Silver Nitrate	Oz.	63¼	@	65
Soapstone, in bags	Ton	10.00	@	12.50
Soda Ash, 58%, in bags	100 Lbs.	2.65	@	2.75
Sodium Acetate, broken lump	Lb.	20	@	21
Sodium Bicarbonate, domestic	100 Lbs.	3.60	@	3.70
Sodium Bichromate	Lb.	22	@	23
Sodium Chlorate	Lb.	25	@	25½
Sodium Cyanide	Lb.	32	@	35
Sodium Fluoride, commercial	Lb.	17	@	18
Sodium Hyposulfite	100 Lbs.	2.60	@	3.60
Sodium Nitrate, 95 per cent, spot	100 Lbs.	4.42½	@	5.00
Sodium Silicate, liquid, 40° Bé		3¼	@	3½
Sodium Sulfide, 60%, fused in bbls	Lb.	nominal		
Sodium Bisulfite, powdered		12	@	14
Strontium Nitrate	Lb.	25	@	30
Sulfur	100 Lbs.	2.25	@	4.60
Sulfuric Acid, chamber 66° Bé	Ton	18.00		
Sulfuric Acid, oleum (fuming)	Ton	32.00		
Talc, American white	Ton	15.00		
Terra Alba, American, No. 1	100 Lbs.	1.17½		
Tin Bichloride, 50°	Lb.	28	@	30
Tin Oxide	Lb.	90	@	1.00
White Lead, American, dry	Lb.	10	@	10½
Zinc Carbonate	Lb.	18	@	20
Zinc Chloride, commercial	Lb.	15	@	15½

ORGANIC CHEMICALS

Acetanilid, C. P., in bbls	Lb.	65	@	70
Acetic Acid, 56 per cent, in bbls	100 Lbs.	9.30	@	9.55
Acetic Acid, glacial, 99½%	100 Lbs.	19.50	@	19.70
Acetone, drums	Lb.	25½	@	
Alcohol, denatured, 180 proof	Gal.	68	@	69
Alcohol, sugar cane, 188 proof	Gal.	4.90	@	4.95
Alcohol, wood, 95 per cent, refined	Gal.	91½	@	92
Amyl Acetate	Gal.	4.20	@	4.50
Aniline Oil, drums extra	Lb.	30	@	32
Benzoic Acid, ex-toluol	Lb.	2.85	@	3.00
Benzol, pure	Gal.	23	@	28
Camphor, refined in bulk, bbls	Lb.	1.24½	@	1.25
Carbolic Acid, U. S. P., crystals, drums	Lb.	42	@	45
Carbon Bisulfide	Lb.	9	@	10
Carbon Tetrachloride, drums, 100 gals	Lb.	nominal		
Chloroform	Lb.	63	@	70
Citric Acid, domestic, crystals	Lb.	1.00	@	1.05
Creosote, beechwood	Lb.	2.00	@	2.10
Cresol, U. S. P.	Lb.	20	@	22
Dextrine, corn (carloads, bags)	Lb.	8	@	9
Dextrine, imported potato	Lb.	nominal		
Ether, U. S. P. 1900	Lb.	27	@	30
Formaldehyde, 40 per cent	Lb.	16¼	Gov't price	
Glycerine, dynamite, drums extra	Lb.	60	@	62
Oxalic Acid, in casks	Lb.	41	@	43
Pyrogallic Acid, resublimed, bulk	Lb.	3.25	@	3.50
Salicylic Acid, U. S. P.	Lb.	85	@	95
Starch, corn (carloads, bags) pearl	100 Lbs.	6.00	@	7.00
Starch, potato, Japanese	Lb.	13	@	14
Starch, rice	Lb.	12½	@	13
Starch, sago flour	Lb.	9¾	@	10¾
Starch, wheat	Lb.	nominal		
Tannic Acid, commercial	Lb.	65	@	80
Tartaric Acid, crystals	Lb.	82	@	85

OILS, WAXES, ETC.

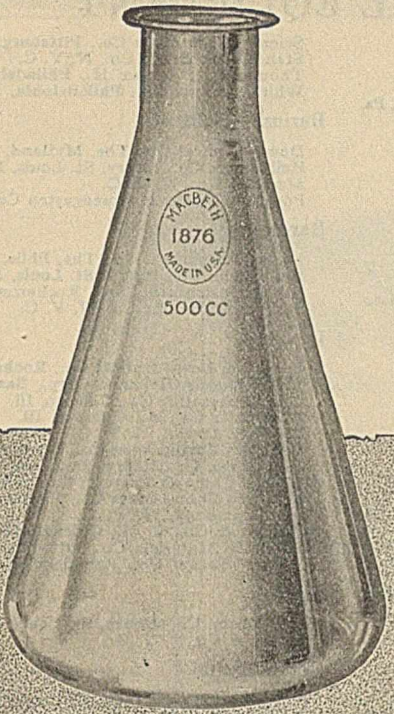
Beeswax, pure, white	Lb.	63	@	65
Black Mineral Oil, 29 gravity	Gal.	24	@	25
Castor Oil, No. 3	Lb.	33¾	@	34½
Ceresin, yellow	Lb.	17	@	18
Corn Oil, crude	100 Lbs.	17.75	@	18.00
Cottonseed Oil, crude, f. o. b. mill	Lb.	17½	@	—
Cottonseed Oil, p. s. y.	100 Lbs.	21.00	@	22.00
Menhaden Oil, crude (southern)	Gal.	1.15	@	1.25
Neat's-foot Oil, 20°	Gal.	3.45	@	3.55
Paraffin, crude, 118 to 120 m. p.	Lb.	9¾	@	10
Paraffin Oil, high viscosity	Gal.	40	@	41
Rosin, "F" Grade, 280 lbs.	Bbl.	15.10	@	15.20
Rosin Oil, first run	Gal.	75	@	76
Shellac, T. N.	Lb.	68	@	70
Spermaceti, cake	Lb.	31	@	33
Sperm Oil, bleached winter, 38°	Gal.	2.23	@	2.25
Spindle Oil, No. 200	Gal.	38	@	40
Stearic Acid, double-pressed	Lb.	24	@	25
Tallow, acidless	Gal.	1.58	@	1.60
Tar Oil, distilled	Gal.	36	@	38
Turpentine, spirits of	Gal.	65	@	66½

METALS

Aluminum, No. 1, ingots	Lb.	33	@	34
Antimony, ordinary	Lb.	13¾	@	14
Bismuth, N. Y.	Lb.	3.50	@	3.65
Copper, electrolytic	Lb.	26	@	
Copper, lake	Lb.	26	@	
Lead, N. Y.	Lb.	8.05		
Nickel, electrolytic	Lb.	55	@	56
Platinum, refined, soft	Oz.	nominal		
Silver	Oz.	1.01⅛		
Tin, Straits	Lb.	nominal		
Tungsten (WO_3)	Per Unit	20.00	@	24.00
Zinc, N. Y.		9.40	@	9.60

FERTILIZER MATERIALS

Ammonium Sulfate	100 Lbs.	4.75	@	—
Blood, dried, f. o. b. Chicago	Unit	6.95		
Bone, 3 and 50, ground, raw	Ton	37.00	@	37.50
Calcium Cyanamide	Unit of Ammonia	nominal		
Calcium Nitrate, Norwegian	100 Lbs.	—		
Castor Meal	Unit	—		
Fish Scrap, domestic, dried, f. o. b. works	Unit	7.25	and	20c
Phosphate, acid, 16 per cent	Ton	16.50	@	17.50
Phosphate rock, f. o. b. mine:	Ton	nominal		
Florida land pebble, 68 per cent	Ton	5.00	@	6.00
Tennessee, 78–80 per cent	Ton	7.00	@	8.00
Potassium "muriate," basis 80 per cent	Ton	300.00	@	310.00
Pyrites, furnace size, imported	Unit	nominal		
Tankage, high-grade, f. o. b. Chicago	Unit	6.75	@	6.80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Absorption Towers

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Duriron Castings Co., N Y. C.
General Ceramics Co.. N. Y. C.
Knight, Maurice A., East Akron, Ohio.
Lummus Co., The Walter E., Boston, Mass.
Thermal Syndicate, Ltd., The, N. Y. C.
U. S. Stoneware Co., The, Akron, O.

Acid and Alkali Resistant Apparatus

Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Cleveland Brass Mfg. Co., The, Cleveland, O.
Duriron Castings Co., N. Y. C.
Elyria Enameled Prod. Co., Elyria, O.
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Pfaudler Co., Rochester, N. Y.

Acid Distillation Apparatus

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Acid Eggs

Bethlehem Fd'y & Mach. Co., So. Beth., Pa.
Buffalo Fdy & Mach. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.
Jacoby, Henry E., N. Y. C.
Schutte & Koerting Co., Philadelphia, Pa.
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Bausch & Lomb Optical Co., Rochester, N. Y.
Guernsey Earthenware Co., The, Cambridge, O.
Heil Chem. Co., Henry, St. Louis, Mo.
Knight, Maurice A., East Akron, O.
Palo Co., N. Y. C.
U. S. Stoneware Co., The, Akron, O.

Acid Plants (Complete or in Part)

Knight, M. A., East Akron, O.

Acid Proof Brick

Belden Brick Co., Canton, O.
General Ceramics Co., N. Y. C.
Knight, M. A., East Akron, Ohio.
U. S. Stoneware Co., The, Akron, O.

Acids

Central Scientific Co., Chicago, Ill.
Dow Chemical Co., The, Midland, Mich.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Palo Company, N. Y. C.
Powers-Weightman-RosengartenCo., Phila., Pa.

Acid Valves

Cleveland Brass Mfg. Co., The, Cleveland, O.
Duriron Castings Co., N. Y. C.
General Ceramics Co., N. Y. C.
Schutte & Koerting Co., Philadelphia. Pa.
United Lined Tube & Valve Co., Boston, Mass.
York Manufacturing Co., York, Pa

Acid Ware

General Ceramics Co., N. Y. C.

Acid Ware (Vitrified Clay)

Guernsey Earthenware Co., The, Cambridge, O.
U. S. Stoneware Co., The, Akron, O.

Agitators or Mixers

Cleveland Brass Mfg. Co., The, Cleveland, O.
Devine Co., J. P., Buffalo, N. Y.
Dorr Co., The, Denver, Col., & N. Y. C.
Duriron Castings Co., N Y. C.
Elyria Enameled Products Co., Elyria, O.
General Filtration Co., Inc., Rochester, N. Y.
Jacoby, Henry E., N. Y. C.
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Crowell Engineering Co., Brooklyn, N. Y.
General Electric Co., Schenectady, N. Y.
Hubbard's Sons, Norman, Brooklyn, N. Y.
Schutte & Koerting Co., Philadelphia, Pa.

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Heil Chem. Co., Henry, St. Louis, Mo.
Powers-Weightman-Rosengarten Co.,Phila.,Pa.
Unger, John S., Chicago Ill.

Ammonia Fittings and Supplies

York Manufacturing Co., York, Pa.

Ammonia—Salts of

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Analysis—Gas Apparatus

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Eimer & Amend, N. Y. C.
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Heil Chem. Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Sarco Co., Inc., N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Thomas Co., Arthur H., Philadelphia, Pa.
Tirrill Gas Mach. Ltg. Co., N. Y. C.

Analytical Apparatus

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Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A, Chicago, Ill.
Eimer & Amend, N. Y. C.
Griebel Instrument Co., Carbondale, Pa.
Heil Chem. Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Thomas Co., Arthur H., Philadelphia, Pa.
Tirrill Gas Mach. Ltg. Co., N. Y. C.

Analytical Laboratories

Columbus Laboratories, Chicago, Ill.
Dearborn Chemical Co., Chicago, Ill.
Sadtler & Son, Samuel P., Philadelphia, Pa.

Aniline Oil—Salts of

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Merck & Co., N. Y. C.

Antimony—Salts of

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Merck & Co., N. Y. C.

Arsenic—Metallic & Salts

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Merck & Co.. N. Y. C.
Powers-Weightman-Rosengarten Co.,Phila.,Pa.

Arsenic Plants (Acid Proof Stoneware)

Knight, M. A., East Akron, O.

Asphalt & Tar Testing Apparatus

Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y C.
Heil Chem. Co., Henry, St. Louis, Mo.
Scientific Materials Co., Pittsburgh, Pa.
Standard Scientific Co., N. Y. C.
Thomas Co., Arthur H., Philadelphia, Pa.

Autoclaves

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Devine Co., J. P., Buffalo, N. Y.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Scientific Materials Co., Pittsburgh, Pa.
Tirrill Gas Mach. Ltg. Co., N. Y. C.

Autoclaves (Glass Enameled Steel)

Pfaudler Co., Rochester, N. Y.

Autoclaves (High and Low Pressure)

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Devine Co., J. P., Buffalo, N. Y.

Automatic Pressure Regulators

Brown Instrument Co., The., Phila., Pa.
Taylor Instrument Cos., Rochester, N. Y

Automatic Temperature Regulators

Brown Instrument Co., The. Phila., Pa.
Engelhard, Charles, N. Y. C.
Taylor Instrument Cos., Rochester, N. Y.

Bakelite

General Bakelite Co., N. Y. C.

Balances and Weights

Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Griebel Instrument Co., Carbondale, Pa.
Heil Chem. Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co.. Pittsburgh, Pa.
Standard Scientific Co., N. Y. C.
Thomas Co., Arthur H., Philadelphia, Pa.
Whitall Tatum Co., Philadelphia, Pa.

Barium—Salts of

Dow Chemical Co., The, Midland, Mich.
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co.,Phila.,Pa.

Barometers

Brown Instrument Co., The, Phila., Pa.
Heil Chem. Co., Henry, St. Louis, Mo.
Taylor Instrument Cos., Rochester, N. Y
Standard Scientific Co., N. Y. C.

Beakers

Bausch & Lomb Optical Co., Rochester, N. Y.
Braun-Knecht-Heimann Corp., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Guernsey Earthenware Co., The, Cambridge, O.
Heil Chem. Co., Henry, St. Louis, Mo.
Herold China & Pottery Co., Golden, Col.
Macbeth-Evans Glass Co., Pittsburgh, Pa.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Whitall Tatum Co., Philadelphia, Pa.

Benzol

Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co.,N. Y. C.

Betanaphthol

Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.

Betanaphthol Apparatus

Buffalo Fdy. & Mch. Co., Buffalo, N. Y.

Bismuth—Metallic & Salts

Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co.,Phila.;

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Central Scientific Co., Chicago, Ill.
Crowell Mfg. Co., Brooklyn, N. Y.
Duriron Castings Co., N. Y. C.
Eimer & Amend, N Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C
Schutte & Koerting Co., Philadelphia, Pa.
Scientific Materials Co., Pittsburgh, Pa.

Boiler Covering

Magnesia Association of America, N. Y. C.

Boiler Water Treatment

Dearborn Chemical Co., Chicago, Ill.
Heil Chem. Co., Henry, St. Louis, Mo.
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Bolting Cloth

Abbé Engineering Co., N. Y. C.

Bone Black

Heil Chem. Co., Henry, St. Louis, Mo.
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Chemical Publishing Co., The, Easton, Pa.
Heil Chem. Co., Henry, St. Louis, Mo.
Sargent & Co., E. H., Chicago, Ill.
Van Nostrand Co., D., N. Y. C.
Wiley & Sons, Inc., John, N. Y. C.

Bottle Blowers

Wheaton Co., T. C., Millville, N. J.

Bottles (Glass)

Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Scientific Materials Co., Pittsburgh, Pa.
Wheaton Co., T. C., Millville, N. J.
Whitall Tatum Co., Philadelphia, Pa.

Brinell Machines

Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Scientific Materials Co., Pittsburgh, Pa.

Burner Guards

Heil Chem. Co., Henry, St. Louis, Mo.
Knight, M. A., East Akron, O.

Burners—Gas and Oil

Bausch & Lomb Optical Co., Rochester, N. Y
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.

CLASSIFIED LIST OF CHEMICAL EQUIPMENT—(*Continued*)

Detroit Heating & Lighting Co., Detroit, Mich.
Eimer & Amend, N. Y. C.
Griebel Instrument Co., Carbondale, Pa.
Heil Chemical Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill
Schutte & Koerting Co., Philadelphia, Pa.
Scientific Materials Co., Pittsburgh, Pa.
Thomas Co., Arthur H., Philadelphia, Pa.
Tirrill Gas Mach. Ltg. Co., N. Y. C.

Burners—Sulphur

Schutte & Koerting Co., Philadelphia, Pa.

Burnishing Pots and Baskets (Acid Proof)

Knight, M. A., East Akron, Ohio.

By-Product Machinery

Devine Co., J. P., Buffalo, N. Y.
Swenson Evaporator Co., Chicago, Ill.

Cabinets (Laboratory, Chemical, Sample and Specimen)

Schwartz Sectional System, Indianapolis, Ind.

Cable & Wire

General Electric Co., Schenectady, N. Y.

Cadmium—Salts of

Dow Chemical Co., The, Midland, Mich.
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co.,Phila.,Pa.

Calcium—Salts of

Dow Chemical Co., The, Midland, Mich.
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co.,Phila.,Pa.

Calorimeters—Fuel and Gas

Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Griebel Instrument Co., Carbondale, Pa.
Heil Chem. Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Sarco Co., Inc., N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Thomas Co., Arthur H., Philadelphia, Pa.

Capsules

Bausch & Lomb Optical Co., Rochester, N. Y
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
Engelhard, Charles, N. Y. C. ("Impervite")
Heil Chem. Co., Henry, St. Louis, Mo.
Norton Co., Worcester, Mass.
Thermal Syndicate, Ltd., The, N. Y. C.

Carbon Bisulfide

Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.

Carbon Tetrachloride

Dow Chemical Co., The, Midland, Mich.
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co.. N. Y. C.
Powers-Weightman-Rosengarten Co.,Phila.,Pa.

Carboys

Whitall Tatum Co., Philadelphia, Pa.

Carboy Inclinators

Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo

Carboy Stoppers

Whitall Tatum Co., Philadelphia, Pa.

Carboy Stoppers (Acid Proof)

Knight, M. A., East Akron, O.

Casseroles

Bausch & Lomb Optical Co., Rochester, N. Y.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Duriron Castings Co., N. Y. C.
Eimer & Amend, N. Y. C.
Guernsey Earthenware Co., The, Cambridge, O.
Heil Chem. Co., Henry, St. Louis, Mo.
Herold China & Pottery Co., Golden, Colo.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.

Castings (Acid and Heat Resisting)

Bethlehem Fd'y & Mach. Co., So. Beth., Pa.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Cleveland Brass Mfg. Co., The, Cleveland, O.
Devine Co., J. P., Buffalo, N. Y.
Duriron Castings Co., N. Y. C.
Jacoby, Henry E., N. Y. C.

Castings—Caustic

Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.

Castings (Chemical)

Bethlehem Fd'y & Mach. Co., So. Beth., Pa
Buffalo Fdy. & Mach. Co., Buffalo, N. Y.
Cleveland Brass Mfg. Co., The, Cleveland, O.
Devine Co., J. P., Buffalo, N. Y.
Duriron Castings Co., N. Y. C.
Jacoby, Henry E., N. Y. C.
Sowers Mfg. Co., Buffalo, N. Y.

Castings—Chemical, Acid and Caustic

Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.

Castings—Evaporator & Vacuum Pan

Buffalo Fdy. & Mch. Co., Buffalo, N Y.
Devine Co., J. P., Buffalo, N. Y.

Caustic Potash

Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co.,Phila.,Pa.

Caustic Pots

Bethlehem Fd'y & Mach. Co., So. Beth., Pa.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.

Caustic Soda

General Chem. Co., N. Y. C.
Heil Chem. Co.. Henry, St. Louis, Mo.
Merck & Co.. N. Y. C.
Powers-Weightman-Rosengarten Co.,Phila.,Pa.

Caustic Soda Dissolvers—Automatic

Lummus Co., The Walter E., Boston, Mass.

Celluloid Scrap

Sereinsky Co., Moses, Indianapolis, Ind.

Cement Filler

Toch Bros, N. Y. C.

Cement Refractory

Heil Chem. Co., Henry, St. Louis, Mo.
Norton Co., Worcester, Mass.

Cement Testing Apparatus

Bausch & Lomb Optical Co., Rochester, N. Y.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Griebel Instrument Co., Carbondale, Pa.
Heil Chemical Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago. Ill.
Scientific Materials Co., Pittsburgh, Pa.
Thomas Co., Arthur H., Philadelphia, Pa.

Centrifugals

Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Cal.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Fletcher Works, Philadelphia, Pa.
Heil Chemical Co., Henry, St. Louis, Mo.
International Equipment Co., Boston, Mass.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Sharples Specialty Co., The, West Chester, Pa.
Tolhurst Machine Works, Troy, N. Y.

Centrifuges

Central Scientific Co., Chicago, Ill.
Heil Chem. Co. Henry, St. Louis, Mo.

Centrifugal Dryers

Fletcher Works, Philadelphia, Pa.

Centrifugal Engineers

Fletcher Works, Philadelphia, Pa.
Sharples Specialty Co., The, West Chester, Pa.
Tolhurst Machine Works, Troy, N. Y.

Cerium Oxalate

Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co.,Phila.,Pa.

Charcoal

Booth Apparatus Co., Syracuse, N. Y.
Heil Chem. Co., Henry, St. Louis, Mo.

Chemical and Process Patents

Foster, A. B., Washington, D. C.

Chemical Apparatus

Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Central Scientific Co.. Chicago, Ill.
Detroit Heating & Lighting Co., Detroit, Mich.
Devine Co. J. P., Buffalo, N. Y.
Eimer & Amend, N. Y. C.
Fletcher Works, Philadelphia, Pa.
Heil Chem. Co., Henry, St. Louis, Mo.
Scientific Materials Co., Pittsburgh, Pa.
Standard Scientific Co., N. Y. C.
Werner & Pfleiderer Co., Inc., Saginaw, Mich.

Chemical Glass Tubing

Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C
Heil Chem. Co., Henry, St. Louis, Mo.

Chemical Glassware

Bausch & Lomb Optical Co., Rochester, N. Y.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago. Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Griebel Instrument Co., Carbondale, Pa.
Heil Chemical Co., Henry, St. Louis, Mo.
Macbeth-Evans Glass Co., Pittsburgh, Pa.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Standard Scientific Co., N. Y. C.
Thomas Co., Arthur H., Philadelphia, Pa.
Wheaton Co., T. C., Millville, N. J.
Whitall Tatum Co., Philadelphia, Pa.

Chemical Mfrs.

Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co.,Phila.,Pa.

Chemical Plants (Complete Installation)

Badger & Sons Co., E. B., Boston, Mass.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.
Knight, M. A., East Akron, O.
Lummus Co., The Walter E., Boston, Mass.
Swenson Evaporator Co., Chicago, Ill.

Chemical Plants (Erected and Supervised)

Badger & Sons Co., E. B., Boston, Mass.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
McNamara, M., Everett, Mass.
Swenson Evaporator Co., Chicago, Ill.

Chemical Reagents

Baker Chem. Co., J. T., Phillipsburg, N. J.
Bausch & Lomb Optical Co., Rochester, N. Y.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
General Chemical Co., Baker & Adamson Works, Easton, Pa.
Heil Chemical Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Palo Company, N. Y. C.
Powers-Weightman-Rosengarten Co.,Phila.,Pa.
Scientific Materials Co., Pittsburgh, Pa.

Chemical Specialties

Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co.,Phila.,Pa.

Chemicals

Baker & Adamson Chemical Co., Easton, Pa.
Baker Chemical Co., J. T., Phillipsburg, N. J.
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill
Dearborn Chemical Co., Chicago, Ill.
Dow Chemical Co., The, Midland, Mich.
Eimer & Amend, N. Y. C.
General Chemical Co., N. Y. C.
Griebel Instrument Co., Carbondale, Pa.
Heil Chemical Co., Henry, St. Louis, Mo.
Kuttroff, Pickhardt & Co., Inc., N. Y. C.
Merck & Co., N. Y. C.
National Aniline & Chemical Co., N. Y. C.
Newport Chemical Works, Inc., N. Y. C.
Palo Company, N. Y. C.
Pfizer & Co., Charles, N. Y. C.
Powers-Weightman-Rosengarten Co.,Phila.,Pa.
Primos Chemical Co., Primos, Del. Co., Pa.
Roessler & Hasslacher Chemical Co., N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Standard Scientific Co., N. Y. C.
Thomas Co., Arthur H., Philadelphia, Pa.
Toch Bros., N. Y. C.

Chemicals—C. P.

Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y C.
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co.,Phila.,Pa.
Scientific Materials Co., Pittsburgh, Pa.

Chemicals—Laboratory

Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co.,Phila.,Pa.
Scientific Materials Co., Pittsburgh, Pa.

Chemicals—Medicinal

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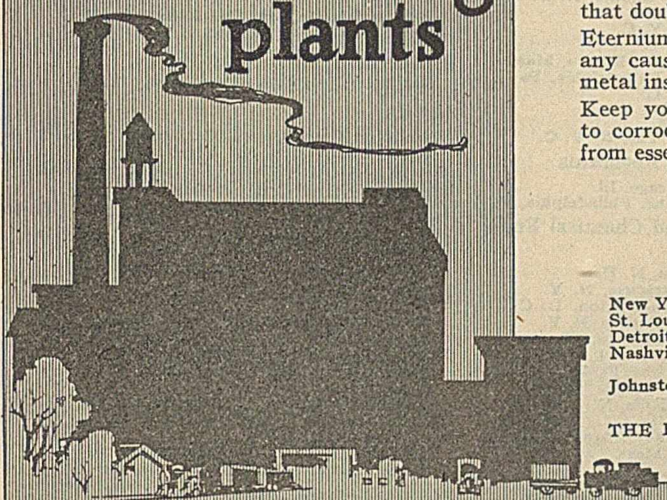

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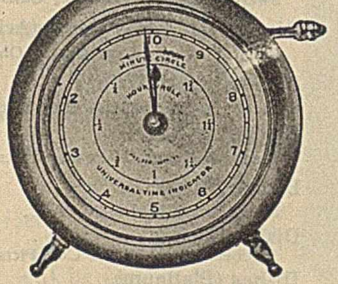

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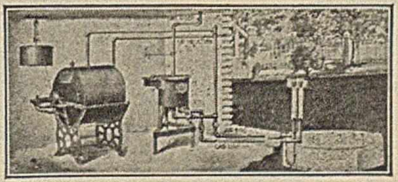

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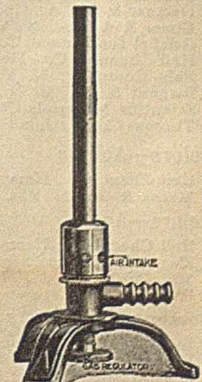


CLASSIFIED LIST OF CHEMICAL EQUIPMENT—(*Continued*)

Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co.,Phila.,Pa.

Chemicals—Photographic
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.

Chemicals—Technical
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co.,Phila.,Pa.

Chemists' and Assayers' Supplies
Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co.,Phila.,Pa.
Scientific Materials Co., Pittsburgh, Pa.

Chlorinators
Wallace & Tiernan Co., Inc., 137 Centre St., N .Y. C.

Chlorine Control Apparatus
Wallace & Tiernan Co., Inc., 137 Centre St., N. Y. C.

Chlorine Generators—Acid Proof
Knight, M. A., East Akron, O.

Chlorine—Liquid
Electro Bleaching Gas Co., N. Y. C.

Chromel Metal
Hoskins Mfg. Co., Detroit, Mich.

Chromium (Metal & Salts)
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co.,Phila.,Pa.

Circuit Breakers and Switches
General Electric Co., Schenectady, N. Y.

Clarifiers
Sharples Specialty Co., The, West Chester, Pa

Classifiers
Dorr Co., The, Denver, Colo., & N. Y. C.

Classifiers or Washers
Dorr Co., The, Denver, Colo., & N. Y. C.

Coal-Tar Products
Barrett Co., The, N. Y. C.
Kuttroff, Pickhardt & Co., N. Y. C.
Merck & Co., N. Y. C.
National Aniline & Chemical Co., N. Y. C.
Newport Chemical Works, Inc., N. Y. C.

Coal-Tar Products (Plants for)
Devine Co., J. P., Buffalo, N Y.

Coal Testing Apparatus
Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
Engelhard, Charles, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Scientific Materials Co., Pittsburgh, Pa.

Cobalt—Metal & Salts
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co.,Phila.,Pa.

Cocks—Plug (Acid Proof)
Cleveland Brass Mfg. Co., The, Cleveland, O.
Duriron Castings Co., N. Y. C.
Knight, M. A., East Akron, O.
United Lined Tube & Valve Co., Boston, Mass
U. S. Stoneware Co., The, Akron, O.

Coils or Worms (Acid Proof Stoneware)
Knight, M. A., East Akron, Ohio.

Colorimeters
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Griebel Instrument Co., Carbondale, Pa.
Heil Chemical Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Thomas Co., Arthur H., Philadelphia, Pa.

Colors—Aniline
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.

Colors—Aniline and Alizarine
Heil Chem. Co., Henry, St. Louis, Mo.
Kuttroff, Pickhardt & Co., N. Y. C.
Metz & Co., H .A., N. Y. C.
National Aniline and Chemical Co., N. Y. C.

Combustion Tubes and Boats
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Engelhard, Charles, N. Y. C. ("Impervite")
General Ceramics Co., N. Y. C.
Guernsey Earthenware Co., The, Cambridge, O.
Heil Chemical Co., Henry, St. Louis, Mo.
Norton Co., Worcester, Mass.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Thermal Syndicate, Ltd., The, N. Y. C.

Combustion Tubes and Boats (Platinum)
Baker & Co., Inc., Newark, N. J.
Heil Chem. Co., Henry, St. Louis, Mo.

Compressors, Rotary
Crowell Mfg. Co., Brooklyn, N. Y.
Devine Co., J. P., Buffalo, N. Y.
Heil Chem. Co., Henry, St. Louis, Mo.

Concentrators—Sulphuric Acid
Thermal Syndicate, Ltd., The, N. Y. C.

Condensers (Barometric and Surface)
Birmingham Mch.& Fd'y Co.,Birmingham, Ala.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.
Duriron Castings Co., N. Y. C.
Jacoby, Henry E., N. Y. C.
Lummus Co., The Walter E., Boston, Mass.
Schutte & Koerting Co., Philadelphia, Pa.
Stevens Brothers, N. Y. C.

Condensers—Nitric Acid
Thermal Syndicate, Ltd., The, N. Y. C.

Conductivity Measuring Apparatus
Central Scientific Co., Chicago, Ill.
Leeds & Northrup Co., The, Philadelphia, Pa.

Consulting Chemists and Chemical Engineers
Abbott, W. G., Jr., Wilton, N. H.
Booth Apparatus Co., Syracuse, N. Y.
Brickenstein, John H., Washington, D. C.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Columbus Laboratories, Chicago, Ill.
Ellis-Foster Co., Montclair, N. J.
Fort Worth Laboratories, The, Ft. Worth, Tex.
Foster, A. B., Washington. D. C
Henderson, R. R., Little Falls, N. J.
Levin, Isaac H., Newark, N. J.
Little, Arthur D., Inc., Cambridge, Mass.
McNamara, M., Everett, Mass.
Mantius, Otto, N. Y. C
Parker, C. L., Washington, D. C.
Sadtler & Son, Samuel P., Philadelphia, Pa
Schwarz Laboratories, N. Y. C.
Singer-Perlstein Co., Milwaukee, Wis.
Stillwell Laboratories, N. Y. C
Sutton, Frank, N. Y. C.
Swenson Evaporator Co., Chicago, Ill.
Townsend, Clinton P., Washington, D. C.
Unger, John S., Chicago, Ill.
Weil, Chas. L., Port Huron, Mich

Contracting Engineers
Swenson Evaporator Co., Chicago, Ill.

Controlling Instruments
Brown Instrument Co., The, Phila., Pa.
Engelhard, Charles, N. Y. C.
Taylor Instrument Cos., Rochester, N. Y.

Converters—Rotary
General Electric Co., Schenectady, N. Y.

Copper—Salts of
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co.,Phila.,Pa.

Cores
Norton Co., Worcester, Mass.

Corn Oil (Extracted)

Counters—Revolution
Brown Instrument Co., Philadelphia, Pa.

Critical Point Determination Apparatus
Brown Instrument Co., Philadelphia, Pa.
Eimer & Amend, N. Y. C.
Engelhard, Charles, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Hoskins Mfg. Co., Detroit, Mich.
Palo Company, N. Y. C.
Scientific Materials Co., Pittsburgh, Pa.
Thwing Instrument Co., Philadelphia, Pa.

Crucibles
Bausch & Lomb Optical Co., Rochester, N. Y
Braun Corporation, Los Angeles, Cal.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Duriron Castings Co., N. Y. C. (Acid-proof.)
Eimer & Amend, N. Y. C.
Engelhard, Charles, N. Y. C. ("Impervite")
Guernsey Earthenware Co., The, Cambridge, O.
Heil Chemical Co., Henry, St. Louis, Mo.
Herold China & Pottery Co., Golden, Col.
Norton Co., Worcester, Mass. (Alundum.)
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Thermal Syndicate, Ltd.,The,N.Y.C.(Vitreosil.)

Crucibles, Platinum
American Platinum Works, Newark, N. J.
Baker & Co., Inc., Newark, N. J.
Bishop & Co., J. Malvern, Pa.
Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Scientific Materials Co., Pittsburgh, Pa.

Crushers and Grinders (Industrial and Laboratory)
Abbé Engineering Co., N. Y. C.
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chemical Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Raymond Bros. Impact Pulv. Co., Chicago, Ill.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Thomas Co., Arthur H., Philadelphia, Pa.
Williams Patent Crusher & Pulv. Co., Chicago.

Crystallizers—Ammonia Nitrate
Buffalo Fdy .& Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.

Crystallizing Pans (Acid Proof)
Knight, M. A., East Akron, Ohio.

Cupels
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Cal.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago. Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chemical Company, Henry, St. Louis, Mo.
Hoskins Mfg. Co., Detroit, Michigan.
Norton Company, Worcester, Mass.

Cylinders (Glass)
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Griebel Instrument Co., Carbondale, Pa.
Heil Chem. Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Scientific Materials Co., Pittsburgh, Pa.
Whitall Tatum Co., Philadelphia, Pa.

Decanting Pots—Acid Proof
Knight, M. A., East Akron, O.

Denitrating Apparatus
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.

Diaphragms—Acid Proof
General Filtration Co., Inc., Rochester, N. Y.
Herold China & Pottery Co., Golden, Colo.

Diffusion Apparatus
Devine Co., J. P., Buffalo, N. Y.
General Filtration Co., Inc., Rochester, N. Y.
Lummus Co., The Walter E., Boston, Mass.
Swenson Evaporator Co., Chicago, Ill.

Dipping Baskets & Jars—(Acid Proof)
Knight, M. A., East Akron, Ohio.

Dishes (Crystallizing)
Macbeth-Evans Glass Co., Pittsburgh, Pa.

Dishes (Glass)
Macbeth-Evans Glass Co., Pittsburgh, Pa

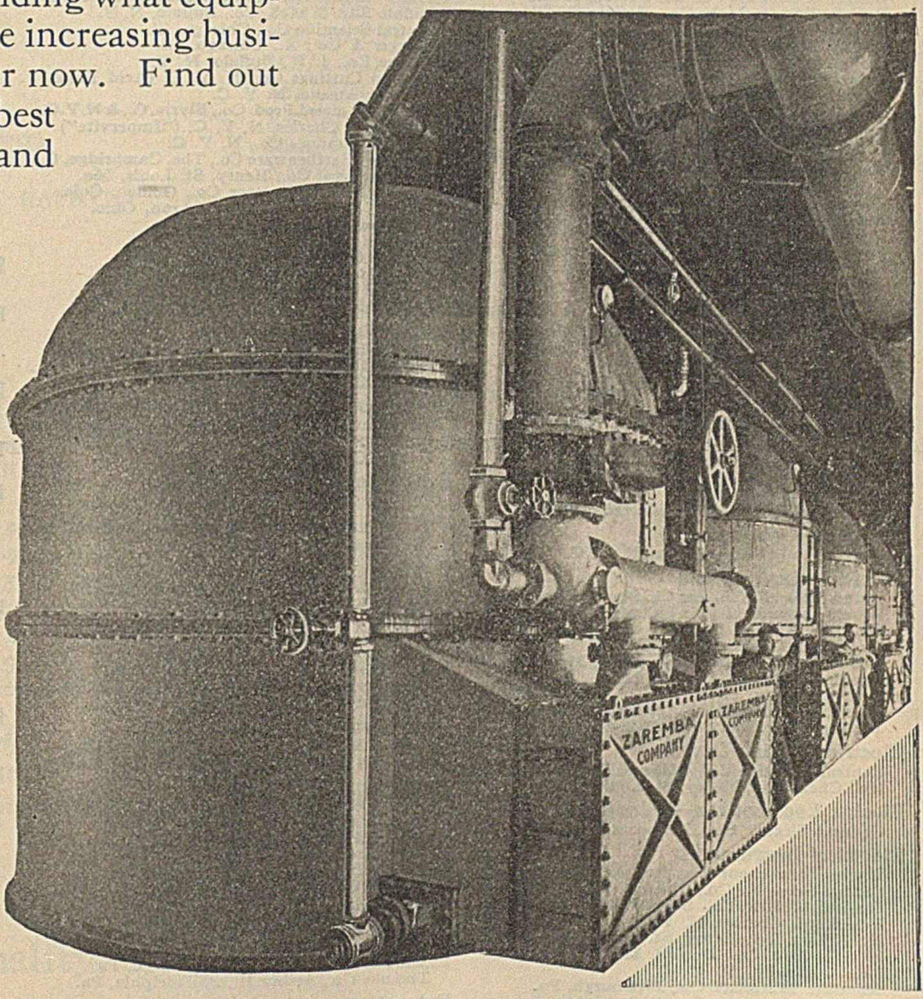
Dishes ("Imperite")
Engelhard, Charles, N. Y. C.

Dishes (Petri)
Macbeth-Evans Glass Co., Pittsburgh, Pa.

Dishes (Platinum)
Bishop & Co., J., Malvern, Pa.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.

Dissolving Tanks—Automatic
Badger & Sons Co., E. B., Boston, Mass.
Lummus Co., The Walter E., Boston, Mass.
Werner & Pfleiderer Co., Saginaw, Mich.

Distilling Machinery and Apparatus
Badger & Sons Co., E. B., Boston, Mass.
Bausch & Lomb Optical Co., Rochester, N. Y.
Birmingham Mch.&Fd'y Co.,Birmingham, Ala.
Booth Apparatus Co., Syracuse, N. Y.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Central Scientific Co., Chicago, Ill.
Cleveland Brass Mfg. Co., The, Cleveland, O.
Daigger & Co., A., Chicago, Ill.
Detroit Heating & Lighting Co., Detroit, Mich
Devine Company, J. P., Buffalo, N. Y.
Duriron Castings Co., N. Y. C.
Eimer & Amend, N. Y. C.
Electric Heating Apparatus Co., N. Y. C.
Elyria Enameled Prod. Co., Elyria, O.
General Ceramics Co., N. Y. C.
Griebel Instrument Co., Carbondale, Pa.
Heil Chem. Co., Henry, St. Louis, Mo.
Jacoby, Henry E. N. Y. C.
Lummus Co., The Walter E., Boston, Mass.
Palo Company, N. Y. C.
Pfaudler Co., Rochester, N. Y.


ZAREMBA COMPANY
ZAREMBA COMPANY

CLASSIFIED LIST OF CHEMICAL EQUIPMENT—(*Continued*)

Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Sowers Mfg. Co., Buffalo, N. Y.
Stokes Machine Company, F. J., Phila., Pa.
Swenson Evaporator Co., Chicago, Ill.
Thomas Co., Arthur H., Philadelphia, Pa.
Unger, John S., Chicago, Ill.
Zaremba Company, Buffalo, N. Y.

Draft Gauges
Braun-Knecht-Heimann Co., San Francisco.
Brown Instrument Co., Philadelphia, Pa.
Central Scientific Co., Chicago, Ill.
Heil Chem. Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Scientific Materials Co., Pittsburgh, Pa.

Drum Dryers—Vacuum and Atmospheric
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.

Dry Blast Plants
Carrier Engineering Corp., N. Y. C.

Dryers—Atmospheric
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.

Dryers—Centrifugals
Fletcher Works, Philadelphia, Pa.

Dryers—Vacuum
Badger & Sons Co., E. B., Boston, Mass.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Company, J. P., Buffalo, N. Y.
Jacoby, Henry E., N. Y. C.
Sowers Mfg. Co., Buffalo, N. Y.
Stokes Machine Co., F. J., Philadelphia, Pa.
Werner & Pfleiderer Co., Saginaw, Mich.

Drying Apparatus and Machinery
Badger & Sons Co., E. B., Boston, Mass.
Birmingham Mch.& Fd'y Co.,Birmingham, Ala.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Central Scientific Co , Chicago, Ill.
Devine Co., J. P., Buffalo, N. Y.
Eimer & Amend, N. Y. C.
Engelhard, Charles, N. Y. C.
General Electric Co., Schenectady, N. Y.
Heil Chem. Co., Henry, St. Louis, Mo.
Jacoby, Henry E., N. Y. C.
Sowers Mfg. Co., Buffalo, N. Y.
Palo Company, N. Y. C.
Werner & Pfleiderer Co., Saginaw, Mich.
Wood, Inc., Henry H., N. Y. C. (Used)

Duriron—Acid-Proof
Duriron Castings Co., N. Y. C.

Dyestuffs
Kuttroff, Pickhardt & Co., Inc., N. Y. C.
Merck & Co., N. Y. C.
Metz & Co., H. A., N. Y. C.
National Aniline & Chemical Co., N. Y. C.

Dynamos and Motors
General Electric Co., Schenectady, N. Y.

Efficiency Gas Burners
Tirrill Gas Mach. Ltg. Co., N. Y. C.

Efficiency Instruments
Braun-Knecht-Heimann Co.,San Francisco,Cal.
Brown Instrument Co., Philadelphia, Pa.
Eimer & Amend, N. Y. C.
Engelhard, Charles, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Hoskins Mfg. Co., Detroit, Mich.
Palo Company, N. Y. C.
Scientific Materials Co., Pittsburgh, Pa.
Thwing Instrument Co., Philadelphia, Pa.

Electric Heating Devices
Central Scientific Co., Chicago, Ill.
Heil Chem. Co., Henry, St. Louis, Mo.

Electric Locomotives—Industrial
General Electric Co., Schenectady, N. Y.

Electrical Instruments
Brown Instrument Co., Philadelphia, Pa.
Central Scientific Co., Chicago. Ill.
General Electric Co., Schenectady, N. Y.
Engelhard, Charles, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Hoskins Mfg. Co., Detroit, Mich.
Palo Company, N. Y. C.
Scientific Materials Co., Pittsburgh, Pa.
Thwing Instrument Co., Philadelphia, Pa.

Electrical Measuring Instruments
Brown Instrument Co., Philadelphia, Pa.
Central Scientific Co., Chicago, Ill.
Engelhard, Charles, N. Y. C.
General Electric Co., Schenectady, N. Y.
Heil Chem. Co., Henry, St. Louis, Mo.
Leeds & Northrup Co., Phila., Pa.
Palo Company, N. Y. C.

Electrical Supplies
General Electric Co., Schenectady, N. Y.

Electrodes—Platinum
American Platinum Works, Newark, N. J.
Baker & Co., Inc., Newark, N. J.
Bausch & Lomb Optical Co., Rochester, N. Y.
Bishop & Co., J., Platinum Works, Malvern, Pa.
Braun Corporation, Los Angeles, Cal.
Braun-Knecht-Heimann Co.,San Francisco,Cal.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Engelhard, Chas., N. Y. C.
Heil Chemical Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.

Electrolytic Apparatus—Acid Proof
Knight, M. A., East Akron, O.

Enameled Apparatus (Acid Resistant)
Elyria Enameled Prod. Co., Elyria, O., &N.Y.C.
Jacoby, Henry E., N. Y. C.
Pfaudler Co., Rochester, N. Y.

Enamel Paint (Impervious to Acid Fumes)
General Bakelite Co., N. Y. C.
Toch Brothers, N. Y. C.

Essential Oils
Merck & Co., N. Y. C.

Evaporating Machinery
Badger & Sons Co., E. B., Boston, Mass.
Birmingham Mch. & Fdy.Co.,Birmingham, Ala.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Company, J. P., Buffalo, N. Y.
Electric Heating Apparatus Co., N. Y. C.
Jacoby, Henry E., N. Y. C.
Lummus Co., The Walter E., Boston, Mass.
Sowers Mfg. Co., Buffalo, N. Y.
Sperry & Co., D. R., Batavia, Ill.
Stokes Mach. Co., F. J., Philadelphia, Pa.
Swenson Evaporator Co., Chicago, Ill.
Werner & Pfleiderer Co., Saginaw, Mich.
Zaremba Company, Buffalo, N. Y.

Evaporating Pans and Dishes
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun-Knecht-Heimann Co.,San Francisco,Cal.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Devine Co., J. P., Buffalo, N. Y.
Duriron Castings Co., N. Y. C. (Acid Proof.)
Eimer & Amend, N. Y. C.
Elvria Enameled Prod. Co., Elyria, O., & N.Y.C.
Engelhard, Charles, N. Y. C. ("Impervite")
General Ceramics Co., N. Y. C.
Guernsey Earthenware Co., The, Cambridge, O.
Heil Chemical Co., Henry, St. Louis, Mo.
Herold China & Pottery Co., Golden, Colo.
Knight, Maurice A., East Akron, Ohio.
Palo Company, N. Y. C.
Pfaudler Co., Rochester, N. Y.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Thermal Syndicate, Ltd., The, N. Y. C.
U. S. Stoneware Co., The, Akron, O.

Evaporators—Crystallizing
Birmingham Mch.&Fd'y Co.,Birmingham, Ala.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.

Evaporators—Single and Multiple Effects
Birmingham Mch.&Fd'y Co.,Birmingham, Ala.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.

Exhaust and Ventilating Fans
General Electric Co., Schenectady, N. Y.

Exhaust and Ventilating Fans—Acid-Proof
Duriron Castings Co., N Y. C.

Extracting Apparatus
Badger & Sons Co., E. B., Boston, Mass.
Central Scientific Co., Chicago, Ill.
Devine Co., J. P., Buffalo, N. Y.
Eimer & Amend, N. Y. C.
Fletcher Works, Philadelphia, Pa.
Heil Chem. Co., Henry, St. Louis, Mo.
Lummus Co., The Walter E., Boston, Mass.
Scientific Materials Co., Pittsburgh, Pa.

Extraction Cylinders
Badger & Sons Co., E. B., Boston, Mass.
Lummus Co., The Walter E., Boston, Mass.

Extraction Thimbles
Angel Co., Inc., H. Reeve, N. Y. C.
Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
Engelhard, Charles, N. Y. C. ("Impervite")
Heil Chem. Co., Henry, St. Louis, Mo.
Norton Co., Worcester, Mass.

Extraction Thimbles (Greens)
Bausch & Lomb Optical Co., Rochester, N. Y.
Eimer & Amend, N. Y. C.
Scientific Materials Co., Pittsburgh, Pa.
Thomas Co., Arthur H., Philadelphia, Pa.

Extractors
Fletcher Works, Philadelphia, Pa.

Extractors—Centrifugal
Fletcher Works, Philadelphia, Pa.
International Equipment Co., Boston, Mass.

Fabroil Gears & Pinions
General Electric Co., Schenectady, N. Y.

Faucets (Stoneware—Acid Proof)
General Ceramics Co., N. Y. C.
Knight, Maurice A., East Akron, Ohio.
U. S. Stoneware Co., The, Akron, O.

Fertilizer Industries Equipment
Schutte & Koerting Co., Philadelphia, Pa.

Filter Cloth (Metallic)
Sweetland Filter Press Co., Brooklyn, N. Y.

Filtering Media
General Filtration Co., Inc., Rochester, N. Y.
Herold China & Pottery Co., Golden, Colo.

Filter Paper
Angel Co., Inc., H. Reeve, N. Y. C.
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chemical Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Thomas Co., Arthur H., Philadelphia, Pa.
Whitall Tatum Co., Philadelphia, Pa.

Filter Paper Clippings
Angel Co., Inc., H. Reeve, N. Y. C.

Filter Paper (Green's)
Bausch & Lomb Optical Co., Rochester, N. Y.
Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Thomas Co., Arthur H., Philadelphia, Pa.

Filter Paper (Whatman)
Angel Co., H. Reeve, N. Y. C.
Bausch & Lomb Optical Co., Rochester, N. Y.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Scientific Materials Co., Pittsburgh, Pa.

Filter Presses (Laboratory & Industrial)
Abbé Engineering Co., N. Y. C.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co.,San Francisco,Cal.
Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Independent Filter Press Co., Inc., Brooklyn, N. Y.
International Filtration Corp., N. Y. C.
Jacoby, Henry E., N. Y. C.
Kelly Filter Press Co., Salt Lake City, Utah.
Lungwitz, E. E., N. Y. C.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsbrugh, Pa.
Shriver & Co., T., Harrison, N. J.
Sperry & Co., D. R., Batavia, Ill.
Sweetland Filter Press Co., Brooklyn, N. Y.

Filter Pulp
Angel Co., Inc., H. Reeve, N. Y. C.

Filters
Engelhard, Charles, N. Y. C. ("Impervite")
General Filtration Co., Inc., Rochester, N. Y.
Norton Co., Worcester, Mass.

Filters—(Acid Proof)
General Filtration Co., Inc., Rochester, N. Y
Knight, Maurice A., East Akron, Ohio.

Filters (Bone Black)
Colwell, Lewis, Chicago, Ill.

Filters, Folded
Angel Co., Inc., H. Reeve, N. Y. C.
Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Scientific Materials Co., Pittsburgh, Pa.

Filters, Folded (Greens)
Bausch & Lomb Optical Co., Rochester, N. Y.
Eimer & Amend, N. Y. C.
Sargent & Co., E. H., Chicago Ill.
Scientific Materials Co., Pittsburgh, Pa.
Thomas Co., A. H., Philadelphia, Pa.

Filters—Vacuum
Devine Co., J. P., Buffalo, N. Y.
General Filtration Co., Inc., Rochester, N. Y.

Filters—Water
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco,Cal.
Booth Apparatus Co., Syracuse, N. Y.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
General Ceramics Co., N. Y. C.
Griebel Instrument Co., Carbondale, Pa.
Heil Chemical Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Schutte & Koerting Co., Philadelphia, Pa.
Thomas Co., Arthur H., Philadelphia, Pa.

Filtros
General Filtration Co., Inc., Rochester, N. Y.

Filtros—Vacuum
Devine Company, J. P., Buffalo, N. Y.

Fire Brick and Clay
Belden Brick Co., Canton, O.

Flasks
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Macbeth-Evans Glass Co., Pittsburgh,Pa.
Palo Company, N. Y. C.
Scientific Materials Co., Pittsburgh, Pa.
Whitall Tatum Co., Philadelphia, Pa.

Fuel Gas Plants
Detroit Heating & Lighting Co., Detroit, Mich.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Tirrill Gas Mach. Ltg. Co., N. Y. C.

Funnels
Heil Chem. Co., Henry, St. Louis, Mo.

Refined Coal-Tar Products

BENZOL, Pure
BENZOL, 100%
BENZOL, 90%
BENZOL, 50%
BENZOL, Straw Color
TOLUOL, Pure
TOLUOL, Commercial
TOLUOL, Straw Color
XYLOL, Pure
XYLOL, Commercial
SOLVENT NAPHTHA
CRUDE SOLVENT NAPHTHA
HI-FLASH NAPHTHA
CRUDE HEAVY SOLVENT NAPHTHA
No. 10 NAPHTHA
HEAVY NAPHTHA
PYRIDIN, Denaturing
PYRIDIN, Commercial
PARACUMARON RESIN
HEAVY SOLVENT OIL
SHINGLE STAIN OIL
SPECIAL HEAVY OIL
SPECIAL HEAVY OIL, Grade 2
NEUTRAL HYDROCARBON OIL
CREOSOTE OIL
CRUDE CARBOLIC ACID, 97-99% Straw Color
CRUDE CARBOLIC ACID, 95% Dark
CRUDE CARBOLIC ACID, 50% 1st Quality
CRUDE CARBOLIC ACID, 25% 1st Quality
CRUDE CARBOLIC ACID, 15% 1st Quality
CRUDE CARBOLIC ACID, 50-60% 2nd Quality
CRUDE CARBOLIC ACID, 25-30% 2nd Quality
CRUDE CARBOLIC ACID, 10-15% 2nd Quality
DIP OIL
PHENOL, U. S. P. Natural
PHENOL, U. S. P. Synthetic
PARA-AMIDOPHENOL
CRESOL, U. S. P.
REFINED CRESYLIC ACID No. 5
ORTHO-CRESOL
META-PARA-CRESOL
XYLENOLS
RESORCIN, Technical
RESORCINOL, U. S. P.
NAPHTHALIN, Flake
NAPHTHALIN, Small Balls
NAPHTHALIN, Large Balls
NAPHTHALIN, Crushed
NAPHTHALIN, Powdered
NAPHTHALIN, Granulated
NAPHTHALIN, Rice
NAPHTHALIN, Lump
NAPHTHALIN, One-ounce Cakes
NAPHTHALIN, Square Tablets
NAPHTHALIN, Round Tablets
CRYST ALBA
NITRONAPHTHALIN
ALPHA-NAPHTHYLAMIN
ANTHRACIN, 80%
CARBAZOL
PHENANTHRIN
SPECIAL CRESOL COMPOUND
DISINFECTANTS, Coefficients 2 to 16
PHTHALIC ACID ANHYDRIDE

We invite inquiries for the various products listed above, but would call attention to the fact that, on some of these items, present heavy contract obligations make immediate offerings impossible.

Assures Quality Barrett Standard and Service

The Barrett Company
Chemical Department

17 Battery Place TRADE B MARK New York, N. Y.

CLASSIFIED LIST OF CHEMICAL EQUIPMENT—(*Continued*)

Knight, M. A., East Akron, Ohio.
Whitall Tatum Co., Philadelphia, Pa.

Furnaces—Annealing—(Hardening and Enameling)
Abbé Engineering Co., N. Y. C.
Brown Instrument Co., Philadelphia, Pa.
Central Scientific Co., Chicago, Ill.
Detroit Heating & Lighting Co., Detroit, Mich.
Electric Heating Apparatus Co., N. Y. C.
General Electric Co., Schenectady, N. Y.
Heil Chem. Co., Henry, St. Louis, Mo.
Hoskins Mfg. Co., Detroit, Mich.
Palo Company, N. Y. C.

Furnaces (Case Hardening, Rivet and Bolt)
Abbé Engineering Co., N. Y. C.

Furnaces—Electric Laboratory
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco, Cal.
Brown Instrument Co., Philadelphia, Pa.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Electric Heating Apparatus Co., N. Y. C.
Engelhard, Chas., N. Y. C.
General Electric Co., Schenectady, N. Y.
Griebel Instrument Co., Carbondale, Pa.
Hanovia Chemical & Mfg. Co., Newark, N. J.
Heil Chem. Co., Henry, St. Louis, Mo.
Hoskins Mfg. Co., Detroit, Mich.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Thomas Co., Arthur H., Philadelphia. Pa.
Tirrill Gas Mach. Ltg. Co., N. Y. C.

Furnaces—(Forge)
Abbé Engineering Co., N. Y. C.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco, Cal.
Electric Heating Apparatus Co., N. Y. C.
Hoskins Mfg. Co., Detroit, Mich.

Furnaces (Melting, Oil or Gas)
Abbé Engineering Co., N. Y. C.
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco, Cal.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Electric Heating Apparatus Co., N. Y. C.
Heil Chemical Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Tirrill Gas Mach. Ltg. Co., N. Y. C.

Furnaces—Muffle
Abbé Engineering Co., N. Y. C.
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco, Cal.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Electric Heating Apparatus Co., N. Y. C.
Engelhard, Charles, N. Y. C.
Heil Chemical Co., Henry, St. Louis, Mo.
Hoskins Mfg. Co., Detroit, Mich.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.

Furnaces—Sulphur
Schutte & Koerting Co., Philadelphia, Pa.

Galvanizing Tanks and Jars—Acid Proof
Knight, M. A., East Akron, O.

Gas Analyzers
Braun-Kneeht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
International Oxygen Co., N. Y. C.

Gas Apparatus
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun-Knecht-Heimann Co., San Francisco Cal.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Detroit Heating & Lighting Co., Detroit, Mich.
Eimer & Amend, N. Y. C.
Heil Chemical Co., Henry, St. Louis, Mo.
International Oxygen Co., N. Y. C.
Palo Company, N. Y. C.
Schutte & Koerting Co., Philadelphia, Pa.
Scientific Materials Co. Pittsburgh, Pa.
Tirrill Gas Mach. Ltg. Co., N. Y. C.

Gas Burners—Incandescent
Detroit Heating & Lighting Co., Detroit, Mich.
Heil Chem. Co., Henry, St. Louis, Mo.
Tirrill Gas Mach. Ltg. Co., N. Y. C.

Gas Control Apparatus
Wallace & Tiernan Co., Inc., 137 Centre St., N. Y. C.

Gas Machines
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago Ill
Detroit Heating & Lighting Co., Detroit, Mich.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Scientific Materials Co., Pittsburgh, Pa.
Tirrill Gas Mach. Ltg. Co., N. Y. C.

Gas Pipe & Fittings (Chamotte)
Knight, M. A., East Akron, O.

Gauges—Recording, Suction & Vacuum
Bausch & Lomb Optical Co., Rochester, N. Y.
Brown Instrument Co., Philadelphia, Pa.
Heil Chem. Co., Henry, St. Louis, Mo.

Gauze—Base Metal
Hoskins Mfg. Co., Detroit, Mich.

Generators (Electro-Oxy-Hydrogen)
International Oxygen Co., N. Y. C.
Shriver & Co., T. Harrison, N. J.

Glass
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis Mo.
Palo Company, N. Y. C.
Scientific Materials Co., Pittsburgh, Pa.
Whitall Tatum Co., Philadelphia, Pa.

Glass Blowing
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco, Cal
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Greiner Co., Emil, N. Y. C.
Griebel Instrument Co., Carbondale, Pa.
Heil Chemical Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa
Standard Scientific Co., N. Y. C.
Tirrill Gas Mach. Ltg. Co., N. Y. C.
Whitall Tatum Co., Philadelphia, Pa.

Glass Enameled Apparatus
Elyria Enameled Prod. Co., Elyria, O., & N. Y. C.
Pfaudler Co., Rochester, N. Y.

Graduates—Glass
Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Macbeth-Evans Glass Co., Pittsburgh, Pa.
Scientific Materials Co., Pittsburgh, Pa.
Whitall Tatum Co., Philadelphia, Pa.

Grinders
Abbé Engineering Co., N. Y. C.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco, Cal.
Raymond Bros. Impact Pulv. Co., Chicago, Ill.
Williams Pat. Crusher & Pulv. Co., Chicago, Ill.

Hardness Testing Apparatus
Braun Corporation, Los Angeles, Cal.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Scientific Materials Co., Pittsburgh, Pa.

Heat Exchangers (Multi-Flow Design)
Birmingham Mch. & Fdy. Co., Birmingham, Ala

Heat Insulation
Magnesia Association of America, N. Y. C.

Heating Apparatus (Laboratory)
Bausch & Lomb Optical Co., Rochester, N Y.
Braun Corporation, Los Angeles, Cal
Braun-Knecht-Heimann Co., San Francisco.
Brown Instrument Co., Philadelphia, Pa.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Electric Heating Apparatus Co., N. Y. C.
General Electric Co., Schenectady, N. Y.
Heil Chem. Co., Henry, St. Louis, Mo.
Hoskins Mfg. Co., Detroit, Mich.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Tirrill Gas Mach. Ltg. Co., N Y. C

Heating Specialties
Detroit Heating & Lighting Co., Detroit, Mich.
Tirrill Gas Mach. Ltg. Co., N. Y. C.

Hot Plates (Laboratory Purposes)
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Cal.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill
Detroit Heating & Lighting Co., Detroit, Mich.
Eimer & Amend, N. Y. C.
Electric Heating Apparatus Co., N. Y. C.
General Electric Co., Schenectady, N. Y.
Heil Chemical Co., Henry, St. Louis, Mo.
Hoskins Mfg. Co., Detroit, Mich.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Thomas Co., Arthur H., Philadelphia, Pa.
Tirrill Gas Mach. Ltg. Co., N Y C.

Hvdro Extractors
Fletcher Works, Philadelphia, Pa.
Tolhurst Machine Works, Troy, N. Y.

Hydrochloric Acid Apparatus
Knight, M. A., East Akron, O.

Hydrogen Generators
International Oxygen Co., N. Y. C.

Hydrogen Plants
Gas Developments Ltd., Walsall, England.
International Oxygen Co., N. Y. C.

Hydrogen (Pure)
International Oxygen Co., N. Y. C.

Hydrygen Testing Apparatus
International Oxygen Co., N. Y. C.

Hydrometers
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Cal.
Braun-Knecht-Heimann Co., San Francisco.
Brown Instrument Co., The, Phila., Pa.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Greiner Co., Emil, N. Y. C.
Griebel Instrument Co., Carbondale, Pa.
Heil Chemical Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Taylor Instrument Cos., Rochester, N. Y.
Thomas Co., Arthur H., Philadelphia, Pa.

Hygrometers
Engelhard, Charles, N. Y. C. (Electric)
Heil Chem. Co., Henry, St. Louis, Mo.
Taylor Instrument Cos., Rochester, N. Y.

Ice-Making Machinery
General Electric Co., Schenectady, N. Y
York Manufacturing Co., York, Pa.

Ichthyol
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.

Impervite Refractories
Engelhard, Charles, N. Y. C.

Impregnating and Drying Apparatus—Vacuum
Buffalo Fdy. & Mch. Co., Buffalo, N. Y
Devine Co., J. P., Buffalo, N. Y.

Incinerators
Tirrill Gas Mach. Ltg. Co., N. Y. C.

Incubators—Surgical
Central Scientific Co., Chicago, Ill.
Heil Chem. Co., Henry, St. Louis, Mo.

Indicating Instruments
Brown Instrument Co., The, Phila., Pa.
Engelhard, Charles, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Taylor Instrument Cos., Rochester, N. Y.

Indicators—(Speed & Test)
Brown Instrument Co., Philadelphia, Pa.
Heil Chem. Co., Henry, St. Louis, Mo.
Scientific Materials Co., Pittsburgh, Pa.

Industrial Burners & Specialties
Heil Chem. Co., Henry, St. Louis, Mo.
Detroit Heating & Lighting Co., Detroit, Mich.
Tirrill Gas Mach. Ltg. Co., N. Y. C.

Industrial Motor Control Devices
General Electric Co., Schenectady, N. Y.

Injectors for Acids and Gases
Knight, M. A., East Akron, O.

Instrument—Precision Manufacturers
Engelhard, Charles, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Scientific Materials Co., Pittsburgh, Pa.

Iodine—Salts of
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co., Phila., Pa.

Iron—Metal and Salts
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co., Phila., Pa.

Iron and Steel Analysis Apparatus—Manufacturers
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Scientific Materials Co., Pittsburgh, Pa.

Jars, Museum & Specimen
Central Scientific Co, Chicago, Ill.
Eimer & Amend, N Y C.
Heil Chem. Co., Henry, St. Louis, Mo.
Whitall Tatum Co., Philadelphia, Pa.

Jars (for Primary & Storage Batteries)
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
General Ceramics Co., N. Y. C.
Guernsey Earthenware Co., The, Cambridge, O.
Heil Chem. Co., Henry, St. Louis, Mo.
Whitall Tatum Co., Philadelphia, Pa.

Jars and Jugs (Acid Storage)
Bausch & Lomb Optical Co., Rochester, N. Y.
General Ceramics Co., N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Herold China & Pottery Co., Golden, Col.
Knight, M. A., East Akron, O.
U. S. Stoneware Co., The, Akron, O.

Kettles—Caustic Soda
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P, Buffalo, N. Y.

Kettles (Chemical Castings)
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N Y.
Cleveland Brass Mfg. Co., The, Cleveland, O.
Devine Co., J. P., Buffalo, N. Y.
Duriron Castings Co., N. Y. C.
Jacoby, Henry E., N. Y. C.
Sowers Mfg. Co., Buffalo, N. Y.

Kettles (Lined)
Badger & Sons Co., E. B., Boston, Mass.
Devine Co., J. P., Buffalo, N. Y.
Elyria Enameled Prod. Co., Elyria, O., N.Y.C.
Pfaudler Co., Rochester, N. Y.
Sowers Mfg. Co., Buffalo, N. Y.

Kettles (Steam Jacketed)
Badger & Sons Co., E. B., Boston, Mass.

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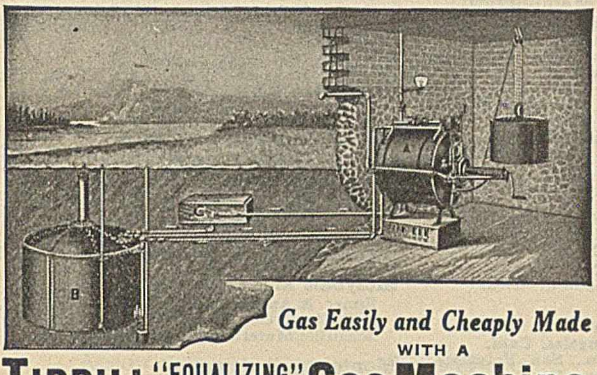

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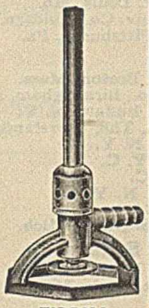

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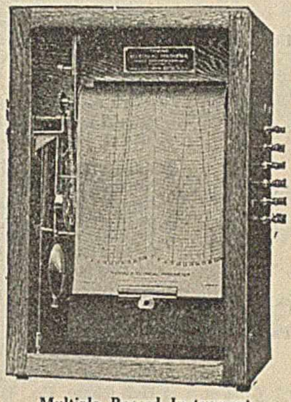

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Kansas City, Mo.—716 Scarritt Bldg.
San Francisco, Cal.—711 Balboa Bldg.

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CLASSIFIED LIST OF CHEMICAL EQUIPMENT—(*Continued*)

Bethlehem Fdy. &Mch. Co., So. Bethlehem, Pa.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Detroit Heating & Lighting Co., Detroit, Mich.
Devine Co., J. P., Buffalo, N. Y.
Duriron Castings Co., N. Y. C.
Elyria Enameled Prod. Co., Elyria, O.
Jacoby, Henry E., N. Y. C.
Pfaudler Co., Rochester, N. Y.
Sowers Mfg. Co., Buffalo, N. Y.
Sperry & Co., D. R., Batavia, Ill.
Stevens Brothers, N. Y. C.
Werner & Pfleiderer Co., Saginaw, Mich.

Kettles (Stoneware)
General Ceramics Co., N. Y. C.
Knight, M. A., East Akron, O.
U. S. Stoneware Co., The, Akron, O.

Kilns (Bone Black)
Colwell, Lewis, Chicago, Ill.

Laboratory Apparatus—Designing & Manufacturing
Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
Engelhard, Charles, N. Y. C.
Fletcher Works, Philadelphia, Pa.
Heil Chem. Co., Henry, St. Louis, Mo.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Standard Scientific Co., N. Y. C.

Laboratory Burners
Central Scientific Co., Chicago, Ill.
Detroit Heating & Lighting Co., Detroit, Mich.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Scientific Materials Co., Pittsburgh, Pa.
Tirrill Gas Mach. Ltg. Co., N. Y. C.

Laboratory Chemicals
Central Scientific Co., Chicago, Ill.
Dow Chemical Co., The, Midland, Mich.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co., Phila., Pa.
Scientific Materials Co., Pittsburgh, Pa.

Laboratory Gas Machine
Central Scientific Co., Chicago, Ill.
Detroit Heating & Lighting Co., Detroit, Mich.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Scientific Materials Co., Pittsburgh, Pa.
Tirrill Gas Mach Ltg. Co., N. Y. C.

Laboratory Glassware
Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C
Heil Chem. Co., Henry, St. Louis, Mo.
Macbeth-Evans Glass Co., Pittsburgh, Pa.
Scientific Materials Co., Pittsburgh, Pa.

Laboratory Supplies
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Detroit Heating & Lighting Co., Detroit, Mich.
Duriron Castings Co., N. Y. C.
Eimer & Amend, N. Y. C.
Engelhard, Charles, N. Y. C.
Greiner Co., Emil, N. Y. C.
Griebel Instrument Co., Carbondale, Pa.
Heil Chem. Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Standard Scientific Co., N. Y. C.
Thomas Co., Arthur H., Philadelphia, Pa.
Tirrill Gas Mach. Ltg. Co., N. Y. C.
Whitall Tatum Co., Philadelphia, Pa.

Laboratory Supplies, Platinum
Central Scientific Co., Chicago, Ill.
Baker & Co., Inc., Newark, N. J.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Scientific Materials Co., Pittsburgh, Pa.

Lacquer
General Bakelite Co., N. Y. C.

Lactic Acid
Heil Chem. Co., Henry, St. Louis, Mo.
Powers-Weightman-Rosengarten Co., Phila., Pa.

Lamps—Arc and Incandescent
General Electric Co., Schenectady, N. Y.

Leaching Cells
Swenson Evaporator Co., Chicago, Ill.
Zaremba Co., Buffalo, N. Y.

Lead Bunring
McNamara, M., Everett, Mass.

Lead Lined Pipe and Accessories
Badger & Sons Co., E. B., Boston, Mass.
Schutte & Koerting Co., Philadelphia, Pa.
United Lined Tube & Valve Co., Boston Mass.

Lightning Arresters
General Electric Co., Schenectady, N. Y.

Linings, Cupola
Herold China & Pottery Co., Golden, Col.

Lithopone
New Jersey Zinc Co., The, N. Y. C.

Lubricants
Dearborn Chemical Co., Chicago, Ill.

Machinery—Chemical
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.
Werner & Pfleiderer Co., Inc., Saginaw, Mich.

Machinery—Electrical
General Electric Co., Schenectady, N. Y.

Machinery—Mining and Metallurgical
Abbé Engineering Co., N. Y. C.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
General Filtration Co., Inc., Rochester, N. Y.
Heil Chem. Co., Henry, St. Louis, Mo.
Scientific Materials Co., Pittsburgh, Pa.
Stokes Machine Co., F. J., Philadelphia, Pa.

Machinery—Mixing and Kneading
Abbé Engineering Co., N. Y. C.
Elyria Enameled Products Co., Elyria, O.
Jacoby, Henry E., N. Y. C.
Pfaudler Co., Rochester, N. Y.
Sowers Mfg. Co., Buffalo, N. Y.
Werner & Pfleiderer Co., Saginaw, Mich.

Machinery—Pulverizing
Abbé Engineering Co., N. Y. C.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Raymond Bros. Impact Pulv. Co., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.

Machinery (Special)
Badger & Sons Co., E. B., Boston, Mass.
Birmingham Mch.&Fdy.Co., Birmingham, Ala.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Cleveland Brass Mfg. Co., The, Cleveland, O.
Devine Co., J. P., Buffalo, N. Y.
Duriron Castings Co., N. Y. C.
Jacoby, Henry E., N. Y. C.
Sowers Mfg. Co., Buffalo, N. Y.
Stevens Brothers, N. Y. C.
Werner & Pfleiderer Co., Saginaw, Mich.

Magnesium—Metal and Salts
Dow Chemical Co., The, Midland Mich.
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-RosengartenCo., Phila., Pa.

Mercury—Salts of
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co., Phila., Pa.

Metallographic Apparatus
Bausch & Lomb Optical Co., Rochester, N. Y.
Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chemical Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Scientific Materials Co., Pittsburgh, Pa.

Metallurgical Laboratory Equipment
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Cal.
Braun-Knecht-Heimann Co., San Francisco, Cal
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Engelhard, Charles, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Hoskins Mfg. Co., Detroit, Mich.
Palo Company, N. Y. C.
Scientific Materials Co., Pittsburgh, Pa.
Thomas Co., Arthur H., Philadelphia, Pa.

Metals (Rare)
Rare Metals Refining Co., Los Angeles, Cal.

Meters—Flow Air, Gas, Water
General Electric Co., Schenectady, N. Y.

Microscopes
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry. St. Louis, Mo.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Thomas Co., Arthur H., Philadelphia, Pa.

Microtomes
Bausch & Lomb Optical Co., Rochester, N. Y.
Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chemical Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Thomas Co., Arthur H., Philadelphia, Pa.

Micro Photo. Apparatus Mfrs.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Scientific Materials Co., Pittsburgh, Pa.

Mills—Ball, Pebble and Tube
Abbé Engineering Co., N. Y. C.
Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.

Mixers
Elyria Enameled Products Co., Elyria, O.
Pfaudler Co., Rochester, N. Y.
Sowers Mfg. Co., Buffalo, N. Y.
Werner & Pfleiderer Co., Saginaw, Mich.

Mixing Tanks
Badger & Sons Co., E. B., Boston, Mass.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Detroit Heating & Lighting Co., Detroit, Mich.
Devine Co., J. P., Buffalo, N. Y.
Duriron Castings Co., N. Y. C.
Elyria Enameled Prod. Co., Elyria, O.
Lummus Co., The Walter E., Boston, Mass.
Pfaudler Co., Rochester, N. Y.
Sowers Mfg. Co., Buffalo, N. Y.
Stevens Brothers, N. Y. C.
Werner & Pfleiderer Co., Saginaw, Mich.

Molybdates
Central Scientific Co., Chicago, Ill.
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co., Phila., Pa.

Molybdic Acid
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Scientific Materials Co., Pittsburgh, Pa.

Montejus—Automatic
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.
General Ceramics Co., N. Y. C.
Knight, Maurice A., East Akron, O.
Schutte & Koerting Co., Philadelphia, Pa.

Mortars & Pestles
Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Scientific Materials Co., Pittsburgh, Pa.
Whitall Tatum Co., Philadelphia, Pa.

Muffles
Eimer & Amend, N. Y. C.
Engelhard, Charles, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Norton Co., Worcester, Mass.
Scientific Materials Co., Pittsburgh, Pa.

Nickel—Salts of
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co., Phila., Pa.

Nitrating Apparatus
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.
Fletcher Works, Philadelphia, Pa.

Nitrating Pots
Bethlehem Fdy. & Mach.Co., So.Bethlehem, Pa.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.
Duriron Castings Co., N. Y. C.
Elyria Enameled Products Co., Elyria, O.
General Ceramics Co., N. Y. C.
Knight, Maurice A., East Akron, O.
Pfaudler Co., Rochester, N. Y.
Sowers Mfg. Co., Buffalo, N. Y.
Stevens Bros., N. Y. C.
U. S. Stoneware Co., The, Akron, O.
Werner & Pfleiderer Co., Saginaw, Mich.

Nitrators—Sulphonators, Etc.
Bethlehem Fdy. & Mach. Co., South Bethlehem, Pa.
Stevens Bros., N. Y. C.

Nitre Pot Acid Pipes
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Cleveland Brass Mfg. Co., The, Cleveland, O.
Duriron Castings Co., N. Y. C. (Special Alloy.)
Elyria Enameled Prod. Co., Elyria, O.
General Ceramics Co., N. Y. C.
Thermal Syndicate, Ltd., N.Y.C. (Silica Ware.)

Nitric Acid Apparatus
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Duriron Castings Co., N. Y. C.

Nitric Acid Plants—Chemical Stoneware
Knight, Maurice A., East Akron, O.

Nitric Acid Retorts
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.

Nozzles (Acid Proof)
Duriron Castings Co., N. Y. C.
Schutte & Koerting Co., Philadelphia, Pa.

Oil Products
National Oil Products Co., Harrison, N. J.

Oil Testing Instruments
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Griebel Instrument Co., Carbondale, Pa.
Heil Chemical Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Taylor Instrument Cos., Rochester, N. Y.
Thomas Co., Arthur H., Philadelphia, Pa.

Optical Instruments
Bausch & Lomb Optical Co., Rochester, N. Y.
Central Scientific Co., Chicago, Ill.


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- Heil Chem. Co., Henry, St. Louis, Mo.
- Palo Company, N. Y. C.
- Thwing Instrument Co., Philadelphia, Pa.

Optical Pyrometer
- Heil Chem. Co., Henry, St. Louis, Mo.
- Palo Company, N. Y. C.
- Scientific Materials Co., Pittsburgh, Pa.

Oxygen (Pure)
- International Oxygen Co., N. Y. C.
- Levin, Isaac H., Newark, N. J.

Oxygen Generators
- International Oxygen Co., N. Y. C.

Oxygen Plants
- International Oxygen Co., N. Y. C.

Oxygen Testing Apparatus
- International Oxygen Co., N. Y. C.

Packings (Condensing Tower)
- General Ceramics Co., N. Y. C.
- Knight, Maurice A., East Akron, O.
- U. S. Stoneware Co., The, Akron, O.

Paints
- Toch Brothers, N. Y. C.

Panels, Rheostats, Motor Generator Sets and Tungar Rectifiers
- General Electric Co., Schenectady, N. Y.

Paper, All Kinds
- Angel Co., Inc., H. Reeve, N. Y. C.

Paranitraniline
- Merck & Co., N. Y. C.

Partition Rings (Chemical Acid Proof)
- Knight, Maurice A., East Akron, O.

Patent Attorneys
- Brickenstein, John H., Washington, D. C.
- Foster, A. B., Washington, D. C.
- Parker, C. L., Washington, D. C.
- Townsend, Clinton P., Washington, D. C.

Percolators
- Badger & Sons Co., E. B., Boston, Mass.
- Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
- Devine Co., J. P., Buffalo, N. Y.
- Elyria Enameled Prod. Co., Elyria, O.
- General Ceramics Co., N. Y. C.
- Pfaudler Co., Rochester, N. Y.
- Whitall Tatum Co., Philadelphia, Pa.

Perhydrol
- Heil Chem. Co., Henry, St. Louis, Mo.
- Merck & Co., N. Y. C.

Pharmaceutical Dryers
- Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
- Werner & Pfleiderer Co., Inc., Saginaw, Mich.

Pharmaceutical Preparations
- Merck & Co., N. Y. C.
- Powers-Weightman-Rosengarten Co.,Phila.,Pa.

Phenol Apparatus
- Buffalo Fdy. & Mch. Co., Buffalo, N. Y.

Photomicrography
- Gravelle, Philip O., S. Orange, N. J.

Photo-Micrographic Apparatus
- Bausch & Lomb Optical Co., Rochester, N. Y.
- Central Scientific Co., Chicago, Ill.
- Eimer & Amend, N. Y. C.
- Heil Chem. Co., Henry, St. Louis, Mo.
- Palo Company, N. Y. C.
- Scientific Materials Co., Pittsburgh, Pa.
- Thomas Co., Arthur H., Philadelphia, Pa.

Physical Apparatus
- Standard Scientific Co., N. Y. C.

Picric Acid Apparatus
- Knight, Maurice A., East Akron, O.

Pipe and Accessories (Acid Proof)
- Bethlehem Fdy.&Mach.Co., So.Bethlehem,Pa.
- Cleveland Brass Mfg. Co., The, Cleveland, O.
- Duriron Castings Co., N. Y. C.
- Elyria Enameled Prod Co., Elyria, O.
- General Ceramics Co., N. Y. C.
- Herold China & Pottery Co., Golden, Col.
- Knight, Maurice A., East Akron, O.
- Schutte & Koerting Co., Philadelphia. Pa.
- Thermal Syndicate, Ltd., N. Y C. (Fused Silica.)
- United Lined Tube & Valve Co., Boston, Mass.
- U. S. Stoneware Co., The Akron, O.

Pipe and Fittings—Lead or Tin Lined
- Schutte & Koerting Co., Philadelphia Pa
- United Lined Tube & Valve Co., Boston, Mass.

Pipe Coverings
- The Magnesia Association of America, N. Y. C.

Pipes—Steam Jacketed
- Devine Co., J. P., Buffalo, N. Y.

Pitch for Protective Coatings
- The Barrett Co., N. Y. C.

Platinum (Sheet, Wire and Foil)
- American Platinum Works, Newark, N. J.
- Baker & Co., Inc., Newark, N. J.
- Bausch & Lomb Optical Co., Rochester, N. Y.
- Bishop & Co., J., Platinum Works, Malvern, Pa.
- Central Scientific Co., Chicago, Ill.
- Daigger & Co., A., Chicago, Ill.
- Eimer & Amend, N. Y C.
- Heil Chemical Co., Henry, St. Louis, Mo.
- Palo Company, N. Y. C.
- Sargent & Co., E. H., Chicago, Ill.

Platinum Ware (Laboratory)
- American Platinum Works, Newark, N. J.
- Baker & Co., Inc., Newark, N. J.
- Bausch & Lomb Optical Co., Rochester, N. Y.
- Bishop & Co., J., Platinum Works, Malvern, Pa.
- Braun Corporation, Los Angeles, Cal.
- Braun-Knecht-Heimann Co., San Francisco.
- Central Scientific Co., Chicago, Ill.
- Daigger & Co., A., Chicago, Ill.
- Eimer & Amend, N. Y. C.
- Engelhard, Chas., N. Y. C.
- Griebel Instrument Co., Carbondale, Pa.
- Heil Chem. Co., Henry, St. Louis, Mo.
- Palo Company, N. Y. C.
- Sargent & Co., E. H., Chicago, Ill.
- Scientific Materials Co., Pittsburgh, Pa.
- Thomas Co., Arthur H., Philadelphia, Pa.

Porcelain Ware—Laboratory
- Bausch & Lomb Optical Co., Rochester, N. Y.
- Braun Corporation, Los Angeles, Calif.
- Braun-Knecht-Heimann Co., San Francisco.
- Central Scientific Co., Chicago, Ill
- Daigger & Co., A., Chicago, Ill.
- Eimer & Amend, N. Y. C.
- Engelhard, Charles, N. Y. C. ("Impervite")
- Griebel Instrument Co., Carbondale, Pa.
- Guernsey Earthenware Co., The, Cambridge, O.
- Heil Chem. Co., Henry, St. Louis, Mo.
- Herold China & Pottery Co., Golden, Col.
- Palo Company, N. Y. C.
- Sargent & Co., E. H., Chicago, Ill.
- Scientific Materials Co., Pittsburgh, Pa.
- Standard Scientific Co., N. Y. C.
- Thomas Co., Arthur H., Philadelphia, Pa.

Portable Ozonators
- General Electric Co., Schenectady, N. Y.

Potassium—Salts of
- Dow Chemical Co., The, Midland, Mich.
- Heil Chem. Co., Henry, St. Louis, Mo.
- Merck & Co., N. Y. C.
- Powers-Weightman-Rosengarten Co.,Phila, Pa.

Pots—Acid Proof Stoneware
- Knight, Maurice A., East Akron, O.

Precision Instrument Makers
- Engelhard, Charles, N. Y. C.
- Heil Chem. Co., Henry, St. Louis, Mo.
- Scientific Materials Co., Pittsburgh, Pa.

Protecting Tubes, Thermocouples
- Brown Instrument Co., The, Phila., Pa.
- Engelhard, Charles, N. Y. C.
- Hoskins Mfg. Co., Detroit, Mich.

Publishers
- Chemical Publishing Co., Easton, Pa.
- Van Nostrand Co., D., N. Y. C.
- Wiley & Sons, Inc., John, N.Y. C.

Pulverizers—Laboratory
- Abbé Engineering Co., N. Y. C.
- Bausch & Lomb Optical Co., Rochester, N. Y.
- Braun Corporation, Los Angeles, Calif.
- Braun-Knecht-Heimann Co., San Francisco.
- Central Scientific Co., Chicago, Ill.
- Daigger & Co., A., Chicago, Ill.
- Eimer & Amend, N. Y. C.
- Heil Chemical Co., Henry, St. Louis, Mo.
- Palo Company, N. Y C.
- Sargent & Co., E. H., Chicago, Ill.
- Scientific Materials Co., Pittsburgh, Pa.
- Sturtevant Mill Co., Boston, Mass.
- Thomas Co., Arthur H., Philadelphia, Pa.
- Williams Patent Crusher & Pulv. Co., Chicago.

Pumps
- Tirrill Gas Mach. Ltg. Co., N. Y. C.

Pumps—Acid
- American Well Works, The, Aurora, Ill.
- Bausch & Lomb Optical Co., Rochester, N. Y.
- Central Scientific Co., Chicago, Ill.
- Cleveland Brass Mfg. Co., The, Cleveland, O.
- Devine Co., J. P., Buffalo, N. Y.
- Duriron Castings Co., N. Y. C.
- Eimer & Amend, N. Y. C.
- General Ceramics Co., N. Y. C.
- Heil Chem. Co., Henry, St. Louis, Mo.
- Palo Company, N. Y. C.
- Schutte & Koerting Co., Philadelphia, Pa.
- United Lined Tube & Valve Co., Boston, Mass.
- U. S. Stoneware Co., The, Akron, O.

Pumps (Chemical)
- American Well Works, The, Aurora, Ill.

Pumps (Laboratory Vacuum)
- Abbé Engineering Co., N. Y. C.
- Bausch & Lomb Optical Co., Rochester, N. Y
- Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
- Central Scientific Co., Chicago, Ill.
- Crowell Mfg. Co., Brooklyn, N. Y.
- Daigger & Co., A., Chicago, Ill
- Devine Co., J. P., Buffalo, N. Y.
- Eimer & Amend, N. Y C
- Heil Chem. Co., Henry, St. Louis, Mo.
- Hubbard's Sons, Norman, Brooklyn, N. Y.
- Palo Company, N. Y. C.
- Sargent & Co., E. H., Chicago, Ill.
- Schutte & Koerting Co., Philadelphia, Pa.
- Thomas Co., Arthur H., Philadelphia, Pa.

Pumps (Vacuum)
- Abbé Engineering Co., N. Y. C.
- Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
- Crowell Mfg. Co., Brooklyn, N. Y.
- Devine Co., J. P., Buffalo, N. Y.
- Jacoby, Henry E., N. Y. C.
- Schutte & Koerting Co., Philadelphia, Pa.

Pump Parts Metal (Acid Proof)
- Duriron Castings Co., N. Y. C.
- Schutte & Koerting Co., Philadelphia, Pa.

Pyrometer Tubes
- Brown Instrument Co., The, Phila., Pa.
- Engelhard, Charles, N. Y. C.
- Norton Co., Worcester, Mass.

Pyrometers
- Bausch & Lomb Optical Co., Rochester, N Y
- Braun Corporation, Los Angeles, Calif.
- Braun-Knecht-Heimann Co., San Francisco.
- Brown Instrument Co., Philadelphia, Pa.
- Central Scientific Co., Chicago, Ill.
- Daigger & Co., A., Chicago, Ill.
- Eimer & Amend, N. Y. C.
- Engelhard, Chas., N. Y. C.
- Greiner Co., Emil, N. Y. C.
- Griebel Instrument Co., Carbondale, Pa.
- Hanovia Chemical & Mfg. Co., Newark, N. J.
- Heil Chem. Co., Henry, St. Louis, Mo.
- Hoskins Mfg. Co., Detroit, Mich.
- Leeds & Northrup Co., The, Philadelphia, Pa.
- Palo Company, N. Y. C.
- Sargent & Co., E. H., Chicago, Ill.
- Scientific Materials Co., Pittsburgh, Pa.
- Taylor Instrument Cos., Rochester, N. Y.
- Thomas Co., Arthur H., Philadelphia, Pa.
- Thwing Instrument Co., Philadelphia, Pa.

Pyrometers—Electrical
- Brown Instrument Co., Philadelphia, Pa.
- Engelhard, Charles, N. Y. C.

Pyrometers (Optical)
- Braun-Knecht-Heimann Co., San Francisco.
- Brown Instrument Co., Philadelphia, Pa.
- Heil Chem Co., Henry, St. Louis, Mo.

Pyrometers (Radiation)
- Brown Instrument Co., The, Phila., Pa.
- Heil Chem. Co., Henry, St. Louis, Mo.
- Leeds & Northrup Co., The, Philadelphia, Pa
- Taylor Instrument Cos., Rochester, N. Y.
- Thwing Instrument Co., Philadelphia, Pa.

Quartz
- Booth Apparatus Co., Syracuse, N. Y.

Quartz Glass
- Bausch & Lomb Optical Co., Rochester, N. Y.
- Braun Corporation, Los Angeles Calif.
- Braun-Knecht-Heimann Co., San Francisco.
- Brown Instrument Co., Philadelphia, Pa.
- Central Scientific Co., Chicago, Ill.
- Daigger & Co., A., Chicago, Ill.
- Eimer & Amend, N. Y. C.
- Engelhard, Chas., N. Y. C.
- Greiner Co., Emil, N. Y. C.
- Griebel Instrument Co., Carbondale, Pa.
- Hanovia Chemical & Mfg. Co., Newark, N. J.
- Heil Chem. Co., Henry, St. Louis, Mo.
- Palo Company, N. Y. C.
- Sargent & Co., E. H., Chicago, Ill.
- Scientific Materials Co., Pittsburgh, Pa.
- Thermal Syndicate, Ltd., The, N. Y. C.
- Thomas Co., Arthur H., Philadelphia, Pa.

Radium
- Eimer & Amend, N. Y. C.
- Heil Chemical Co., Henry, St. Louis, Mo.
- Palo Company, N. Y. C.

Reagent Bottles
- Central Scientific Co., Chicago, Ill.
- Eimer & Amend, N. Y. C.
- Heil Chem. Co., Henry, St. Louis, Mo.
- Scientific Materials Co., Pittsburgh, Pa.
- Whitall Tatum Co., Philadelphia, Pa.

Reagents—Chemical
- Baker & Adamson Chem. Co., Easton, Pa.
- Baker Chem. Co., J. T., Phillipsburg, N. J.
- Bausch & Lomb Optical Co., Rochester, N. Y.
- Braun-Knecht-Heimann Co., San Francisco.
- Central Scientific Co., Chicago, Ill.
- Daigger & Co., A., Chicago, Ill.
- Eimer & Amend, N. Y. C.
- Griebel Instrument Co., Carbondale, Pa.
- Heil Chemical Co., Henry, St. Louis, Mo.
- Merck & Co., N. Y. C.
- Palo Company, N. Y. C.
- Powers-Weightman-Rosengarten Co. Phila.,Pa.
- Sargent & Co., E. H., Chicago, Ill.
- Scientific Materials Co., Pittsburgh, Pa.
- Thomas Co., Arthur H., Philadelphia, Pa.

Recording Instruments
- Braun-Knecht-Heimann Co., San Francisco.
- Brown Instrument Co., Philadelphia, Pa.
- Central Scientific Co., Chicago, Ill.
- Eimer & Amend, N. Y. C.
- General Electric Co., Schenectady, N. Y.
- Heil Chem. Co., Henry, St. Louis, Mo.
- Hoskins Mfg. Co., Detroit, Mich.
- Palo Company, N. Y. C.
- Scientific Materials Co., Pittsburgh, Pa.
- Taylor Instrument Cos., Rochester, N. Y.
- Thwing Instrument Co., Philadelphia, Pa.

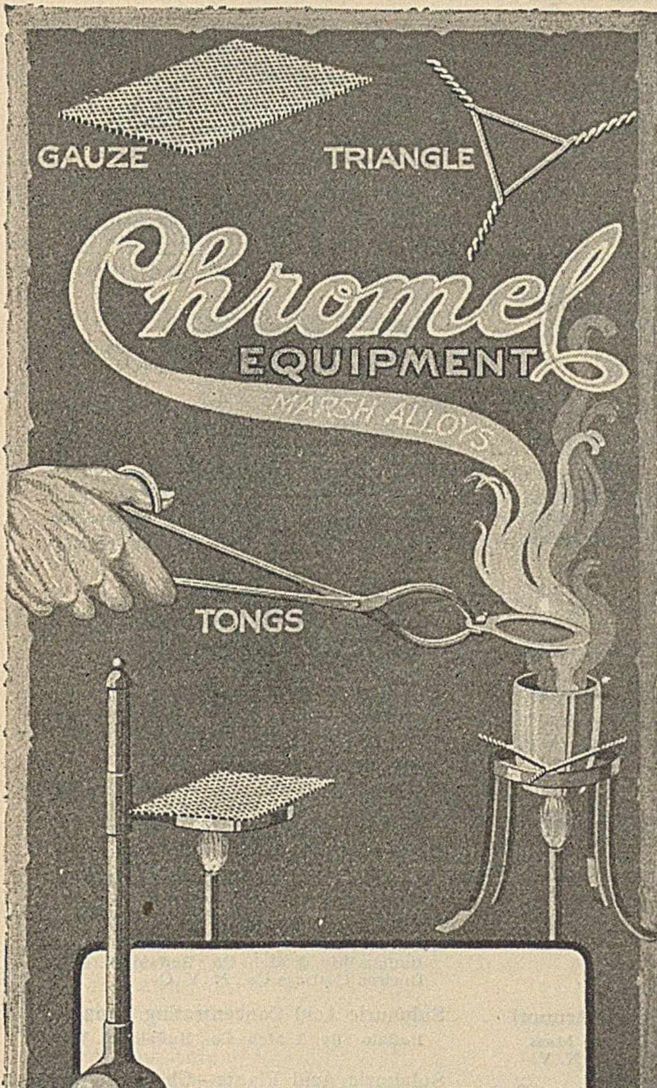
Recording Instruments (For Pressure, Temperature, Etc.)
- Brown Instrument Co., Philadelphia, Pa.
- Engelhard, Charles, N. Y. C.
- Heil Chem. Co., Henry, St. Louis, Mo.
- Scientific Materials Co., Pittsburgh, Pa.
- Taylor Instrument Cos., Rochester, N. Y.

Reduction Kettles
- Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
- Devine Co., J. P., Buffalo, N. Y.

Refineries—(Oil—Sugar Installation)
- Lummus Co., The Walter E., Boston, Mass.

Refractories
- Engelhard, Charles, N. Y. C.
- Guernsey Earthenware Co., The, Cambridge, O
- Heil Chem. Co., Henry, St. Louis, Mo.
- Herold China & Pottery Co., Golden, Colo.
- Norton Co., Worcester, Mass.

Refrigerating Machinery and Apparatus
- General Electric Co., Schenectady, N. Y.
- York Manufacturing Co., York, Pa.



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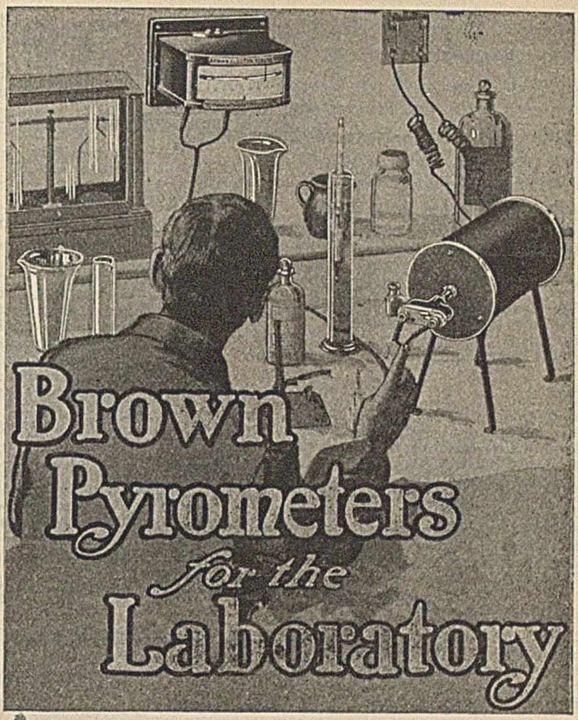

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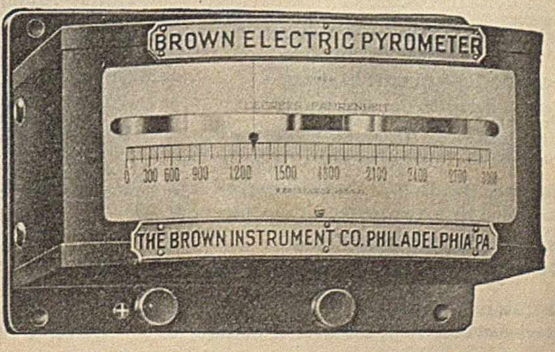

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Regulators (Automatic Humidity)
Carrier Engineering Corp., N. Y. C.

Relays
General Electric Co., Schenectady, N. Y.

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Heil Chem. Co., Henry, St. Louis, Mo.
Hoskins Mfg. Co., Detroit, Micb

Resistance Wire—Base Metal
Heil Chem. Co., Henry, St. Louis, Mo.
Hoskins Mfg. Co., Detroit, Mich.

Resistance Wire—Platinum
American Platinum Works, Newarx, N. J.
Baker & Co., Inc., Newark, N. J.
Bishop & Co. Platinum Wks., J., Malvern, Pa.
Heil Chem. Co., Henry, St. Louis, Mo.

Retorts
Badger & Sons Co., E. B., Boston, Mass.
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun-Knecht-Heimann Co., San Francisco.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Central Scientific Co., Chicago, Ill.
Daigger & Co. A., Chicago, Ill.
Devine Co., J. P., Buffalo, N. Y.
Heil Chemical Co., Henry, St. Louis, Mo.
Lummus Co., The Walter E., Boston, Mass.
Palo Company, N. Y. C.
Thermal Syndicate, Ltd., The, N. Y. C.

Retorts (Cast Iron)
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.
Heil Chem. Co., Henry, St. Louis, Mo.
Sargent & Co., E. H., Chicago, Ill.
Sowers Mfg. Co., Buffalo, N. Y.

Retorts—Acid (Cast Iron)
Bethlehem Fdy. & Mach. Co., So. Beth., Pa.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.
Griebel Instrument Co., Carbondale, Pa.
Herold China & Pottery Co., Golden, Col.

Rotary Compressors or Blowers
Abbé Engineering Co., N. Y. C.
Crowell Mfg. Co., Brooklyn, N. Y.

Rotary Dryers—Vacuum and Atmospheric
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.

Rotary Lead Fans
Schutte & Koerting Co., Philadelphia, Pa.

Rubber Goods—Hard
Goodrich Rubber Co., The B. F., Akron, O.

Rubber Tubing (Laboratory)
Angel Co., Inc., H. Reeve, N. Y. C.
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Griebel Instrument Co., Carbondale, Pa.
Heil Chemical Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Thomas Co., Arthur H., Philadelphia, Pa.
Tirrill Gas Mach. Ltg. Co., N. Y. C.
Whitall Tatum Co., Philadelphia, Pa.

Scientific Apparatus
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Cal.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Engelhard, Charles, N. Y. C.
Heil Chemical Co., Henry, St. Louis, Mo.
Hoskins Mfg. Co., Detroit, Mich.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Standard Scientific Co., N. Y. C.

Scientific Instrument Makers
Central Scientific Co., Chicago, Ill.
Engelhard, Charles, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Scientific Materials Co., Pittsburgh, Pa.

Screens (Grinding & Pulverizing)
Raymond Bros. Impact Pulv. Co., Chicago, Ill.

Searchlights and Headlights
General Electric Co., Schenectady, N. Y.

Separators—Air
Raymond Bros. Impact. Pulv. Co., Chicago, Ill.

Separators—Centrifugal
Fletcher Works, Philadelphia, Pa.
International Equipment Co., Boston, Mass.
Sharples Specialty Co., The, West Chester, Pa.
Tolhurst Machine Works, Troy, N. Y.

Sheet Metal Apparatus (Special)
Tirrill Gas Mach. Ltg. Co., N. Y. C.

Shelf Dryers—Vacuum
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.

Shredders
Williams Patent Crusher & Pulv. Co., Chicago, Ill.

Silica—Fused
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Calit.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
Engelhard, Chas., N. Y. C.
Greiner & Co., Emil, N. Y. C.
Greibel Instrument Co., Carbondale, Pa.
Heil Chem. Co., Henry, St. Louis, Mo.
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Scientific Materials Co., Pittsburgh, Pa.
Thermal Syndicate, Ltd., The, N. Y. C.
Thomas Co., Arthur H., Philadelphia, Pa.

Sinks, Laboratory Acid Proof
Duriron Castings Co., N. Y. C.
Knight, Maurice A., East Akron, O.

Soda Recovery Machinery
Devine Co., J. P., Buffalo, N. Y.
Swenson Evaporator Co., Chicago, Ill.

Sodium-Benzol-Sulphonate Dryers
Buffalo Fdy. & Mch Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.

Sodium—Salts of
Dow Chemical Co., The, Midland, Mich.
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co., Phila., Pa.

Soldering Iron Heaters
Tirrill Gas Mach. Ltg. Co., N. Y. C.

Solenoids
Central Scientific Co., Chicago, Ill.

Solvent Recovery Apparatus (Vacuum)
Badger & Sons Co., E. B., Boston, Mass.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.
Elyria Enameled Prod. Co., Elyria, O.
Lummus Co., The Walter E., Boston, Mass.
Pfaudler Co., Rochester, N. Y., & N. Y. C.
Sowers Mfg. Co., Buffalo, N. Y.
Werner & Pfleiderer Co., Saginaw, Mich.

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New Jersey Zinc Co., The, N. Y. C.

Spiegeleisen
New Jersey Zinc Co., The. N. Y. C.

Spray Nozzles
Schutte & Koerting Co., Philadelphia, Pa.

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Steam Reducing Valves
Taylor Instrument Cos., Rochester, N. Y.

Steam Traps
Sarco Co., Inc., N. Y. C.

Sterilizers
Central Scientific Co., Chicago, Ill.
Heil Chem. Co., Henry, St. Louis, Mo.

Stills—Aniline, Phenol and Betanaphthol
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.

Stills—Nitric Acid and Sulfuric Acid
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.

Stirring Apparatus
Booth Apparatus Co., Syracuse, N. Y.
Cleveland Brass Mfg. Co., The, Cleveland, O.
Devine Co., J. P., Buffalo, N. Y.
Duriron Castings Co., N. Y. C.
Elyria Enameled Prod. Co., Elyria, O.
Jacoby, Henry E., N. Y. C.
Palo Company, N. Y. C.
Pfaudler Co., Rochester, N. Y.
Sowers Mfg. Co., Buffalo, N. Y.
Stevens Brothers, N. Y. C.
Werner & Pfleiderer Co., Saginaw, Mich.

Stoneware—Chemical (Laboratory)
Bausch & Lomb Optical Co., Rochester, N. Y.
Braun Corporation, Los Angeles, Calif.
Braun-Knecht-Heimann Co., San Francisco.
Central Scientific Co., Chicago, Ill.
Daigger & Co., A., Chicago, Ill.
Eimer & Amend, N. Y. C.
General Ceramics Co., N. Y. C.
Griebel Instrument Co., Carbondale, Pa.
Heil Chem. Co., Henry, St. Louis, Mo.
Knight, Maurice A., East Akron, Ohio
Palo Company, N. Y. C.
Sargent & Co., E. H., Chicago, Ill.
Schutte & Koerting Co., Philadelphia, Pa.
Scientific Materials Co., Pittsburgh, Pa.
Thomas Co., Arthur H., Philadelphia, Pa.
U. S. Stoneware Co., The, Akron, O.

Stoneware (Acid Proof—Industrial Purposes)
General Ceramics Co., N. Y. C.
Knight, M. A., East Akron, O
Schutte & Koerting Co., Philadelphia, Pa.
U. S. Stoneware Co., The, Akron, O.

Stoppers—Rubber
Central Scientific Co., Chicago, Ill.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.
Scientific Materials Co., Pittsburgh, Pa.
Whitall Tatum Co., Philadelphia, Pa.

Storage Battery Recharging Apparatus
General Electric Co., Schenectady, N. Y.

Strontium—Salts of
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co., Phila., Pa.

Sugar Mill Machinery
Birmingham Mch. & Fdy. Co., Birmingham, Ala.
Devine Co., J. P., Buffalo, N. Y.
Swenson Evaporator Co., Chicago, Ill.

Sulphonating Apparatus
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Devine Co., J. P., Buffalo, N. Y.
Duriron Castings Co., N. Y. C.

Sulphuric Acid
Heil Chem. Co., Henry, St. Louis, Mo.
New Jersey Zinc Co., The, N. Y. C.
Powers-Weightman-Rosengarten Co., Phila., Pa.

Sulphuric Acid Apparatus
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Duriron Castings Co., N. Y. C.

Sulphuric Acid Concentrating Pans
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.

Sulphuric Acid Plants—Chemical Stoneware
Knight, M. A., East Akron, O.

Sulphuric Acid Recovery Apparatus
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.

Switchboards
General Electric Co., Schenectady, N. Y.

Synthetic Oils & Chemicals
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.

Syphons
General Ceramics Co., N. Y. C.
Standard Scientific Co., N. Y. C.

Syphons—Steam Jet
Cleveland Brass Mfg. Co., The, Cleveland, O.
Duriron Castings Co., N. Y. C. (Acid Proof.)
Elyria Enameled Prod. Co., Elyria, O.
Schutte & Koerting Co., Philadelphia, Pa.

Tachometers
Brown Instrument Co., Philadelphia, Pa.
Palo Company, N. Y. C.
Taylor Instrument Cos., Rochester, N. Y.
Eimer & Amend, N. Y. C.
Heil Chem. Co., Henry, St. Louis, Mo.

Talc
Heil Chem. Co., Henry, St. Louis, Mo.
Merck & Co., N. Y. C.
Powers-Weightman-Rosengarten Co., Phila., Pa.

Tanks—(For Acid or Basic Reaction)
Badger & Sons Co., E. B., Boston, Mass.
Buffalo Fdy. & Mch. Co., Buffalo, N. Y.
Chadwick-Boston Lead Co., Boston, Mass.
Cleveland Brass Mfg. Co. The, Cleveland, O.
Devine Co., J. P., Buffalo, N. Y.
Duriron Castings Co., N. Y. C.
Elyria Enameled Products Co., Elyria, O.
General Ceramics Co N. Y. C.
Knight, Maurice A., East Akron, O.
Lummus Co., The, Walter E., Boston, Mass.
Pfaudler Co., Rochester, N. Y.
U. S. Stoneware Co., The, Akron, O.