Progress of a Year—A Chemical Review

By D. H. Killeffer, Associate Editor

UNCLE REMUS, that delightful old negro philosopher who gladdened the hearts of children, and grown-ups, of an earlier generation, once extolled in glowing terms the virtues of a rabbit's foot as a protection against all evil and an assurance of success to any kind of an undertaking. When he had finished, he cannily added that its effectiveness was greatly enhanced "ef de man w'at got it know 'zactly w'at he got ter do." A great many industrial enterprises in the past were content with the mere possession of a fancied rabbit's foot of monopoly and seemed to care little whether or not they followed the old darky's addendum and knew exactly what to do. That, of course, was in the past, for today very few indeed could afford to risk going without the necessary "know how." The marvelous development of those industries which have removed the burden from their respective rabbits' feet and placed it on that sure source of "know how," the modern research laboratory, is too obvious an object lesson to need remark here, but the vast accomplishment of research is a continuing source of wonder and amazement even to those immediately responsible for it.

Three Great Research Funds Initiated

The need for community brains in the form of great research organizations is making itself felt even by the much maligned "man in the street," and within the past twelve months three great research projects designed particularly for the public good as distinct from individual or corporate benefit have been launched. Seeds planted and efforts initiated during the early days of the World War—what centuries of history our race has lived through in a bare twelve years—have reached the point of building and blossoming and one may be encouraged to hope for their ultimate fruition. It is quite beyond the powers of anyone to estimate in advance what the relative merits of any of these endowments will be when measured in the future in terms of achievement, for they are as yet mere vague foreshadowings of what may or may not come to pass.

More than two years ago a committee of the American Petroleum Institute at the instigation of B. T. Brooks drew up a report on the latent possibilities of petroleum as a source of chemical raw materials with the idea of interesting capital in endowing research to bring them out. As is often the way with well-meant efforts of this character, the report was given more or less perfunctory consideration and pigeonholed. Nothing apparently was going to be done about it, and at the Baltimore meeting of the AMERICAN CHEMICAL SOCIETY C. H. Herty set off an unsuspected bomb under those who should have provided action by calling vigorous attention to the dearth of research by the petroleum industry beyond that having a direct bearing on its production problems. So completely had the report been forgotten that petroleum chemists rose in arms against what they considered to be an entirely unjustified attack upon them and as a result of the disturbance thus created attention was forcefully called to the oversight and action initiated. The first gift for this purpose was made by John D. Rockefeller of a fund of $250,000 to be available, under the trusteeship of W. C. Teagle, J. C. Donnell, and R. L. Welch, in five equal annual instalments, and this was followed by an equal sum given under similar conditions by the Universal Oil Products Company. These two gifts make $100,000 per year for five years available for research in the chemistry of petroleum. In general, it is expected that the work to be done under grants from these funds will be in the field of pure science, and will presumably be carried out through subsidies to research workers in existing institutions rather than by the building of a new one. Any results are to be available to the public. Final plans of administration are being prepared by the American Petroleum Institute with the coöperation of various committees of the National Research Council. No announcement of grants from this fund has been made, but it is understood that this will follow the completion of arrangements now under way.

The plan of the National Academy of Sciences is broader and includes the endowment of research in pure science in every field for the general good of future generations. Realizing that advances in applied science which contribute so largely to the wealth and comfort of modern civilization can only be expected on the basis of the now thankless labor of pure science, the Academy has set out to accumulate a fund of $20,000,000 to support fundamental research and to reduce the great gap which now separates the rewards of the academician and the industrialist. The purposes of this fund are of the highest, but its very nature, the intangibility of the results of pure science, is making its accumulation difficult as it has made it all the more necessary. Few serious modern undertakings are more romantic. One need but vision the trials Galileo and Copernicus endured in reaching the conclusions which are at the basis of modern mechanics and which made the navigation of the seven seas as usual and as certain a thing as rowing about a mill pond, and contrast these with the efficiency, and the comparative ease, comfort, and appreciation such an endowment will make possible for future Newtons, Lavoisiers, and Daltons, to build a romance that will attract even the most frivolous. The fund, under a special board of trustees of which Secretary Hoover is chairman, has reached a total of more than $3,000,000 contingent upon raising the whole fund, and although this is being increased from time to time the activity of its promoters is being carried on so quietly that few know it is going on at all. Naturally, plans for its expenditure await developments, but it is understood that it will be used to initiate and further research in existing institutions.

The third great endowment of research is in a nebulous and uncertain state. Indeed, it is as yet no more than a gigantic conception, which may take years to materialize, if it ever does. Following the ideas promulgated years ago by a committee of the AMERICAN CHEMICAL SOCIETY as set forth in the little volume, "The Future Independence and Progress of American Medicine in the Age of Chemistry," Senator Ransdell of Louisiana has introduced a bill into the Senate calling for the creation of a National Institute of Health on a huge scale for the development of medicine and of the treatment of disease. The bill is designed to provide for enlargements of the Hygienic Laboratory and for the construction and endowment by the Government of an institution in which the ablest workers of the country may be gathered and which may function as well for instruction as for research. This measure was introduced into the Senate just before the summer recess and no action was taken upon it.

What may be accomplished by any or all of these projects is of course a matter of conjecture, but that good will result no one can doubt. The initiation of three such programs within a single year is a sure sign of greatly increased public interest in, and appreciation of, science and research.

Another movement of interest to the chemical profession no less than to the world at large has been started by Francis P. Garvan for the coöperative study of the common cold. A committee is being formed of representatives of chemistry, medicine, pharmacy, bacteriology, and other professions interested to correlate and encourage a program of research looking to the elimination of this disagreeable and expensive accompaniment of modern life. The completion of this plan, for it is nothing more at present, is not expected until late in the year and its goal is still far in the future.

Important Meetings

The year 1926 is notable in the annals of American chemistry not only as a year of forward-looking research programs but as a milepost of progress. Fifty years ago the AMERICAN CHEMICAL SOCIETY held its first meeting and the guess was hazarded that there might be within the area embodying New York, Philadelphia, Boston, and Albany as many as a hundred chemists in addition to the thirty-six present at the SOCIETY'S first meeting who might be persuaded to join with them in forming a great society. This estimate was made with fear and trembling at the time, yet it is dwarfed into insignificance beside a membership in the SOCIETY fifty years afterward that is more than a hundred times as great and is scattered to the four corners of the earth. So important an anniversary in chemistry falls at the same time as the one hundred and fiftieth of the founding of our republic and both have been fittingly celebrated at Philadelphia by leaders of chemistry and of political life from all the world.

In addition to this important meeting of the SOCIETY, it participated worthily in an international discussion of political affairs at the Institute of Politics, at Williamstown, Mass., during the month of August. In the invitation to take part in this discussion was evidence of a public realization that chemistry is a distinct and important power in the modern world, and in the participation was proof of this. The discussion carried on before the Institute was on the general subject, "The Role of Chemistry in the World's Future Affairs." Four principal aspects of this subject were discussed—Energy, Industrial Raw Materials, Food, and Health. Each of these subjects was discussed at three meetings of the round table devoted to this general subject and at one general conference attended by all members of the Institute (some three hundred leaders in all lines of endeavor). In addition, a number of popular lectures, including a series of six by Principal Sir James Irvine, of St. Andrews University, Scotland, and special addresses by Umberto Pomilio, of Naples, and Justin du Pont, of France, dealt with further details of the subject.

During September the International Union of Pure and Applied Chemistry was the guest of the Division of Chemistry and Chemical Technology of the National Research Council at Washington, another important event as showing in a measure the respect felt by our brethren of other nations for our accomplishments and abilities in our chosen field.

These three events have been of inestimable importance to American chemists themselves in giving them an opportunity to meet and greet distinguished foreign contemporaries and to look forward as well as backward to the importance of their own accomplishments and to great expectations of the future.

Progress of Pure Science

Naturally, the first interest in the recent results of research attaches to the doings of investigators in pure science for their researches today will be the industrial practice of tomorrow. The chemistry of cap and gown as distinct from that of overalls has suffered neglect in recent years as the latter has been able to offer its rewards more generously and in much more tangible form. The movement of well-qualified men from institutions of learning, where an opportunity is offered for research in pure science, to industries, where rewards are more certain and where more generous comforts are assured, has been going on at an increasing rate. No particular examples of this have stood out in the past twelve months, but the increasing necessity for an adequate supply of the results of research in pure science has become more and more obvious as industry has put to work one after another of the dusty specimens in chemistry's museum. It is the dire prospect of draining the existing stock of such latent possibilities without in the meantime assuring their replacement that has initiated such determined efforts to increase the attractiveness of the type of research now carried on for truth's sake only.

Illinium

The most interesting, and perhaps important, achievement of pure science during the last year has been the discovery and identification of element No. 61, by B. S. Hopkins and his associates at the University of Illinois. The new element, which has long been sought to fill the gap in the periodic system, falls among the rare earths between neodymium and samarium and has been called "illinium." It was discovered by x-ray methods and has not yet been isolated. Its atomic weight lies between 144 and 150 and active steps are being taken toward its isolation and complete identification. The name applied to the new element is derived from the name of the state in which it was discovered and is pronounced ĭl-lĭn'ĭum.

This discovery leaves only two vacancies in the periodic table as now constituted—in the alkali family, whose unknown member in period seven, atomic number 87, is probably radioactive; and in the halogen family, atomic number 85. One cannot but wonder whether the discovery of these two missing elements will finally and completely end the catalog of the constituents of our universe, or whether the periodic system, which has served so well as the guiding light of research for so many years, will not have to be seriously amended to give chemistry still other worlds to conquer.

Atomic Hydrogen

Among other additions to the list of achievements of pure science which have not yet been commercialized has been a most interesting study of the properties of atomic hydrogen. At Princeton University H. S. Taylor has been investigating the chemical activity of atomic hydrogen produced by the bombardment of hydrogen molecules by mercury atoms excited by ultra-violet light from a mercury vapor lamp. He has found that many reactions which could not be carried out with molecular hydrogen are easily possible under these conditions. For instance, the preparation of hydrogen peroxide has formerly required a more or less complicated series of reactions, but the direct oxidation of atomic hydrogen under controlled conditions will yield hydrogen peroxide immediately instead of water. The possibilities which this opens for future research are both interesting and important as a method of preparation not only of compounds of hydrogen but of those of other elements which may be produced in an atomic state by a similar treatment.

It is interesting to note in this connection the use of atomic hydrogen in the oxyhydrogen blowpipe. By passing the hydrogen to the flame through an electric arc, the hydrogen molecules appear to be broken up into atoms and the resulting flame produces temperatures much higher than can otherwise be obtained. This work was done in the Research Laboratory of the General Electric Company.

Chemotherapy

In the field of chemotherapy a number of important researches are going on and a few of these have reached a point to encourage high hopes of their ultimate success. The valuable constituent of insulin has been prepared in crystalline form by Abel, of Johns Hopkins University, and it is hoped that the study of this crystalline compound may lead to its synthesis in the laboratory. At the University of Illinois, Adams has prepared synthetically compounds related to those present in chaulmoogra oil, and laboratory tests (*in vitro*) indicate that these chaulmoogric acid derivatives have a considerably higher germicidal value than the natural products. The difficulty in working with these compounds, among which it is hoped to find a more effective remedy for leprosy, is that it is impossible to transmit leprosy to the lower animals for test purposes and hence it is necessary to go directly from bacteriological studies to clinical experiments on human beings. The necessary clinical data cannot be collected except by long periods of study, so that it is probable that a year or two must be consumed before any definite data as to the relative values of synthetic and natural materials can be determined.

Industrial Progress

Naturally, this is a very meager treatment of the vast amount of research in pure chemistry that is recorded in the year's literature. It would be quite beyond the range of possibility to go into all of it and to pick out for discussion each item that offered special interest. In the applied chemistry of overalls the task is no less imposing, but a few outstanding features strike one forcibly as bearing definitely upon progress. Most of these really represent nothing more than a removal of the dust of years from interesting specimens laid away by academic scientists of a generation ago and a refurbishing of these for activity in the industrial field.

Carbon Dioxide Ice

Every student of elementary chemistry or physics for many academic generations has been told or shown that solid carbon dioxide is to be had by releasing liquid carbon dioxide from a cylinder under proper circumstances and that the snow thus produced is very cold indeed. It is only within a comparatively few months, however, that steps have been taken to put this interesting substance to work. A hammer of frozen mercury is an interesting toy to be shown to students, but the world's interest is immediately aroused when it is shown that a carload of beef or of fruit can be kept cold by carbon dioxide ice easier and cheaper than by water ice while it is traveling across the country from areas of surplus to consuming markets.

The commercial application of carbon dioxide ice has barely begun and the makers of ice from water have not yet shut up shop, but preliminary practical tests so far made indicate that much may be expected from this new type of portable refrigeration. Its principal advantage apparently lies in the fact that it evaporates slowly from the solid to the gaseous state without becoming liquid and that the heat absorbed by this change is considerably greater than by the melting of ice. In addition to this, the gaseous carbon dioxide released in the refrigerated space apparently has an additional preservative effect on food products, reducing their tendency to spoil, presumably by oxidation. Efforts made in England and Germany a number of years ago to apply this refrigerant to commercial operations failed, but it is possible that conditions in America today, particularly long freight hauls for food products, will make it practicable on the large scale required for success in such an undertaking. It has been found possible by using a small block of solid carbon dioxide to keep ice cream in a paper carton frozen for thirty-six hours, and one of the large retailers of ice cream in New York City has successfully used this method of conveying small lots of its product to consumers.

Ethylene Glycol

An even more musty specimen, one not used even for exhibition purposes, ethylene glycol, has become a strikingly important industrial material within a year. While ethylene glycol has been offered on the market for several years in limited amounts, it has not been widely used on account of the high price necessitated by small-scale production, but recent increases in its utility are rapidly making it commercial. During the past winter considerable quantities of ethylene glycol were used with marked success to prevent freezing of automobile radiators. Later, a variety of solvents, ethers of ethylene glycol, were synthesized, and since these possess very high solvent capacity for nitrocellulose they are finding ready use in the lusty infant industry of lacquer manufacture. The ethyl ether of ethylene glycol, $CHOC_2H_5.CHOH$, is particularly efficient as a solvent for cellulose esters, and other derivatives possess other valuable solvent properties. The fact that these compounds are practically odorless and produce no disagreeable physiological effects makes them particularly desirable in lacquers for use indoors. A third large use of ethylene glycol, one which may be expected to consume even larger quantities of glycol than those mentioned, is as a substitute for diglycerol in the manufacture of low-freezing dynamites. A number of other properties of dinitroglycol, in addition to its effect in lowering the freezing point of trinitroglycerol, with which it is mixed in such dynamites, make it especially desirable for this use.

These commercial uses of ethylene glycol, announced in a single year, required the background of a number of years' research to bring them to that point. In distinct contrast to the recent history of glycol is the almost complete lack of interest on the part of the soap-makers, who turn out immense quantities of glycerol, in research that might lead to a strengthening of its commercial position. Just at the moment the market for glycerol is in excellent condition from the makers' point of view. The entire production is being passed readily into consumption at profitable prices and there is no immediate prospect of a change in this situation. However, glycol in dynamite and its use as an antifreeze for automobiles are directed definitely at a large—perhaps the largest—present market for glycerol and at a future demand for it on which soap-makers are depending to absorb any expanded production of their industry. Under the circumstances, the industry being now profitably busy and threatened by a young but lusty competitor whose product is made from an abundant raw material (ethylene) and is not in any sense a by-product, as glycerol is from soap, it is to be deplored that the soap industry has been unwilling to embark upon a carefully planned program of research to assure itself a continuing profitable market for glycerol.

Calcium Cyanide

Calcium cyanide is noted in the literature as an unknown, theoretical compound in the same class, perhaps, as carbonic acid, but within the year it has been prepared on a commercial scale and put to use. It is so easily hydrolyzed by water that it cannot exist in water solution nor can it be formed by a reaction which liberates water. Its commercial value lies in its very weakness, for its ease of hydrolysis makes it a convenient form for transporting hydrocyanic acid. In order to make it the very unusual method is employed of treating calcium carbide with hydrocyanic acid. Acetylene is evolved

and calcium cyanide formed in the complete absence of water. When thus prepared calcium cyanide is a fine powder, which is readily decomposed into lime and hydrocyanic acid on exposure to the moisture of the air. By transporting it in sealed drums out of contact with air or moisture, it may be preserved until ready for use as a fumigant, and it is merely necessary to expose it to the atmosphere to get a copious evolution of hydrocyanic acid. So readily does this decomposition occur that the fruit-growers are sold calcium cyanide as "powdered hydrocyanic acid," which cannot be considered a misnomer unless one is inclined to split hairs.

New Syntheses of Phenol

Two new syntheses of phenol have been developed during the past year and are now in the preliminary stages of industrial application. One of these is based upon the hydrolysis of monochlorobenzene by steam to form phenol directly. The other consists in the direct oxidation of benzene in the vapor phase by air in the presence of a catalyst. The first substitutes steam for an alkali and is thus more economical than the accustomed method of using caustic soda to hydrolyze monochlorobenzene. The oxidation method substitutes air, which is our cheapest oxidizing agent, for sulfuric acid or chlorine. The proponents of both of these processes expect that they will effect considerable economies in the manufacture of phenol, as one would be led to believe by theoretical considerations, but neither process has yet stood the test of large-scale commercial use. New syntheses of phenol are particularly important to the industry of synthetic plastics.

Vulcanization Accelerators

The subject of accelerators for the vulcanization of rubber was given a complete airing at the hearing, before Judge A. N. Hand in the United States District Court for the Southern District of New York, of a suit brought by the Grasselli Chemical Company against the National Aniline & Chemical Company on the basis of U. S. Patent No. 1,149,580, bought by the Grasselli Company with other assets of the Bayer Company during the war. This litigation was brought to establish the validity of the claims of this patent, covering as accelerators organic ammonium compounds having a basic reaction at vulcanization temperatures and a dissociation constant greater than 1×10^{-8}. The particular substance chosen for the basis of the suit was diphenylguanidine, and expert testimony was introduced to show that this claim covered practically all accelerators now in common use except the recently discovered super-accelerators. On this account practically every rubber manufacturer was represented at the trial and awaits the decision of the court with great interest. The accounting and recovery of profits asked by the plaintiff would involve the entire rubber industry. Very few patents now in effect are so broadly fundamental to an industry as this one.

Antioxidants for Rubber

The introduction of such a substance as the condensation product of α-naphthylamine and acetaldol in such small proportions as 0.5 to 1 per cent on the basis of the rubber in a compound has been found to delay materially the disintegration of the rubber through age. Improvement is noted in reclaimed rubber compounds by the use of 3 to 4 per cent of such an antioxidant. The particular value of antioxidants in the rubber industry is in correcting faulty batches. A poorly compounded or incorrectly mixed batch can be corrected and made to give satisfactory service by the addition of small quantities of these substances. The action of these compounds is not complete in stopping aging but they do make it considerably slower than otherwise and are thus valuable. At least two compounds of this nature have been put on the market within a year.

Alloys

Research in alloys has been directed particularly toward the finding of light alloys for use in aircraft. Much of the research along this line has been the subject of papers in THIS JOURNAL dealing with cast-aluminum alloys, but in addition the alloys of beryllium (glucinum) with aluminum and magnesium are being intensively investigated. So far the high cost of beryllium ($200 a pound) has prevented its practical application, but if the alloys made from it prove useful in large quantities this figure can undoubtedly be brought down to a commercial level. Beryllium imparts strength and hardness to aluminum without increase of weight.

Another alloy of some interest is that of manganese with magnesium, which is very light but unfortunately too brittle for structural use. This alloy has been found to possess a high elasticity and consequently very remarkable acoustic properties. The damping of vibration when a piece of it is struck is very slight and it will continue to ring for several minutes. It is hoped that this may find application in acoustical apparatus such as radio loud-speakers and bells.

Electroplated Alloys

One is accustomed to think of electroplating as a process for separating metals and one expects an electroplated metal to be particularly pure. However, during the past year two alloys have been successfully electrodeposited on a commercial scale. The first of these was a nearly pure chromium containing about 2 per cent of other metals to assist in the formation of a perfect coating on metal articles to resist abrasion and corrosion. The remarkable properties of this chromium plate have led to its wide use within the past year. The second instance of electroplating of an alloy was that of Permalloy. This is quite definitely an alloy, containing about one part of iron and four parts of nickel. It has been successfully plated in commercial quantities and this method will probably lead to distinct economies in its application to submarine cables.

Potash Developments

The potash industry has been increasingly active during the year and the output of the plant on Searles Lake is being doubled. Production by a new process from New Jersey greensand has been started on a pilot-plant scale. The new greensand process[1] consists in treating the greensand with sulfuric acid to convert the iron, aluminum, and potash to the sulfates. The solution of these salts may then be crystallized, the iron converted to the insoluble oxide by calcination, the aluminum converted to its insoluble oxide by still further heating, and the potassium sulfate leached out for use. This process is now in the semicommercial state, and its promoters hope shortly to put it on a large-scale basis. The advantages claimed for it as compared with previous processes operated on greensand are the recovery of an absorptive silica, a large part of the sulfuric acid used by the calcination of the iron and aluminum sulfates, and the value of the oxides obtained as by-products.

Legislation passed just before the adjournment of Congress involves the appropriation of public funds for the complete and careful investigation by the Departments of the Interior and Agriculture of the potash deposits known to exist in Texas. These deposits, which were discovered in drilling for oil, are believed by many to be of vast extent and the idea behind present legislation is to finance core drilling in

[1] Turrentine, THIS JOURNAL, **17**, 1177 (1925).

the prospective field with the idea of determining this definitely. The small chance of success in this and the high cost of such operations have discouraged private capital from undertaking so large a task. It is prognosticated that this may be the world's largest potash field, and if this is found to be true the economic importance of the find can scarcely be overestimated.

Ammonia Synthesis

Ammonia synthesis is progressing rapidly in this country and a number of new plants are being built or planned for operating various processes. The first American plant employing the Claude process was put into operation during the year and has a rated capacity of 25 tons of ammonia per day. A number of smaller units employing various modifications of the Haber and Claude processes are being installed to utilize by-product hydrogen. Notable among these is the 15-ton plant now being erected by the Commercial Solvents Corporation to utilize the hydrogen produced in its fermentation process. It is estimated that seven plants now operating in the United States produce a total of about 70 tons of ammonia per day and have a capacity of 88 tons per day.

Rayon

During the past year some observers have seen what they consider to be a decided movement of the cotton manufacturers to install and operate for their own use plants for the manufacture of rayon. One such plant is now in definite operation by the Amoskeag Manufacturing Company at Manchester, N. H., producing about 600 to 700 pounds of rayon per day by the viscose process. Several smaller units have been installed by other cotton manufacturers and finishers, but it is understood that this has not reached the proportions of a movement and probably will not. The rayon industry in the United States produced 51,791,173 pounds of rayon and related products in 1925 valued at $87,940,937. This represents an increase of 43.3 per cent in poundage and 48.9 per cent in value over 1923.

Viscose Wool

An Italian process for the production of wool-like fibers has been put into operation during the year and samples of this wool and cloth made from it have been sent to this country. The process is understood to be slightly modified from the viscose rayon process and produces fibers closely resembling wool. The modifications have to do with the make-up of the spinneret forcing the viscose to crinkle, coagulation without tension, cutting of the fiber into short lengths, and slight changes in the composition of the viscose and the coagulating bath. It is too early yet to forecast the economic importance of this process, but many believe that it will not be so important as rayon because of the lower value of wool as compared with silk.

Political Chemistry

Rubber has attracted a great deal of political, as well as chemical, attention as a result of the efforts on the part of the British to maintain prices by limiting exports. An investigation of the price situation by a committee of Congress at the instigation of Secretary Hoover showed that the price of rubber was being held at what is considered an unfair level by the British plan of restricting exports. In addition to rubber, this report deplored a similar monopolistic control over coffee by the state of Sao Paulo, over nitrates and iodine by Chile, over potash by Germany and France, over long staple cotton by Egypt, over camphor and silk by Japan, and over sisal by Yucatan. The report added that such monopolies by foreign governments are economically unsound and could very well be the causes of international irritation that might lead to war. Characteristically, nothing has been done about it and it is rather doubtful if anything will. In the meantime crude rubber prices have adjusted themselves to a point around 40 cents in the New York market and the Stevenson plan is being revised to increase this price.

Tetraethyl Lead Investigation

The report of the Surgeon General's committee on the hazard of tetraethyl lead as an ingredient of motor fuel gave this valuable material a provisionally clean bill of health, and its manufacture and sale to the public under careful supervision have been resumed. The remarkable thing about the investigations carried on under the direction of this committee was the finding of lead in detectable amounts in normal human beings who had not been exposed to any known lead hazard. This startling fact was clearly brought out after the development of special methods of analysis for detecting lead accurately in human excreta. The surprising thing about this was that a number of individuals who had not been exposed to lead hazards showed an actually larger excretion of lead than others who had been definitely exposed to the hazard of tetraethyl lead in motor fuel.

Chemistry of Petroleum

The use of petroleum as a chemical raw material, so often stressed as one of the prospects of the future, is already being practiced commercially in the plant of the Barnsdall Corporation, at Tiverton, R. I., in addition to the activities of other oil companies in the manufacture of alcohols from cracking gases. This plant is turning out a variety of materials for use as solvents in quantities of some 20,000 gallons per month. Among these are several not commercially important before; for example, anhydrous tertiary amyl and tertiary butyl alcohols, which are now available in lots of 55 gallons in drums at $1.50 and $1.15 per gallon, respectively. These two alcohols are to be had in a very pure state. Similar processes yield a variety of other alcohols which are converted into esters and sold as mixtures for use as solvents. Three of these solvents derived from petroleum are now offered, one consisting essentially of isopropyl acetate, another of a mixture of secondary butyl and secondary amyl acetates, and a high-boiling solvent based on secondary hexyl acetate. The first of these is to be had at 85 cents per gallon, the second at a price based on that of normal butyl acetate but somewhat lower, and the third at $1.75 per gallon. Another more or less miscellaneous mixture of hydrocarbons and alcohols is offered as a motor fuel for which valuable antiknock properties are claimed. This is the first commercial production of these secondary and tertiary alcohols.

Suit over Cracking Patents

Two public investigations during the year have had to do with the petroleum industry. During the fall of 1925 a lengthy trial of the Government's suit against the oil companies charging illegal monopoly on the basis of the patents held on cracking processes dragged itself out through many weeks of expert testimony and recrimination from opposing witnesses. No decision has yet been reached in this case, but at least it has served to call serious attention to the defects in our present system of expert witnesses and thus good may be accomplished as a result of it whatever the final verdict may be.

Oil Conservation

The Federal Oil Conservation Board appointed by the President as a result of the scandals growing out of the

Teapot Dome affair has recently reported, and its public hearings and the accumulation of data for its perusal have brought many important and interesting phases of the petroleum situation to the fore. The board's report was issued early in September and decries wasteful methods of using oil which are rapidly depleting our reserves.

The statements made before this board regarding the advance of cracking processes in converting low-grade fuel oils into high-priced gasoline are particularly apropos as an indication of the role to be played by this factor in our future fuel supply. W. C. Teagle, of the Standard Oil Company of New Jersey, is sponsor for the statement that during the last three years "gasoline was produced more cheaply from cracking than from the initial distillation of the crude, and in this way by utilizing only distillates 144 million barrels of cracked gasoline were produced. To have produced this 144 million barrels of cracked gasoline from the initial distillation of crude* * *would have necessitated the running of 585 million barrels of crude. Thus the cracking process during the past three years actually conserved this 585 million barrels of crude which is in excess of the total quantity of crude now in storage in the United States." Mr. Teagle points out that economic conditions—the price of crude, the value of gasoline, the value of fuel oil, and the cost of the cracking process—are given what amounts to a free hand to control the balance between gasoline and fuel-oil production by the perfection of industrially practicable processes for cracking the latter to produce more of the former. He suggests 5 cents per gallon as the cost of the cracking process and looks for further development in this line to lead to an even more economical conservation of petroleum resources.

Industrial Alcohols

Prohibition continues to occupy much of the thought and energy of the nation. The administration of General Lincoln C. Andrews as Federal Prohibition Director has directed its energies toward stopping the sources of supply of illicit alcoholic beverages and among these denatured alcohol has loomed large in the minds of prohibitionists. Formulas 2 and 6 for completely denatured alcohol have been revoked within the past few months and Formula 5 has been considerably revised with a view to making more difficult the large-scale rectification for beverage purposes believed to be going on. Formula 2 as revoked called for the addition of two gallons of approved wood alcohol and one-half gallon of approved pyridine to each hundred gallons of ethyl alcohol. Formula 6 as revoked involved the addition of two gallons of approved benzene, one-fourth gallon of approved pyridine bases, and one-half gallon of benzine (kerosene) to each hundred gallons of ethyl alcohol. The reason given for revoking these two formulas was that bootleggers had succeeded in taking them apart. One can scarcely imagine that a plant containing so efficient a fractionating column as would be required for this purpose and large enough for economical operation could remain hidden for long under a bushel. In addition to the withdrawal of two formulas for completely denatured alcohol, Formula 5 has been changed by an increase in its methanol content.

Pure Food Law Unchanged

During the year a determined effort was made on the part of the manufacturers of dextrose to put through Congress a measure permitting its use in food products without the necessity of referring to it on the label of the package. This was the first assault of the kind upon the Federal Food and Drugs Act, to obtain a definite modification of its provisions. The effort failed and it is now important only as indicating that such efforts to modify this important piece of legislation may be expected from other sources. The requirement of the law that sugar shall be understood to mean cane sugar and no other, and that when another sugar is used it must be so noted on the label of the food package, is of little real significance at present when dextrose of high purity and nutritional value is available, but such provisions of the law have been to some extent deterrents to sophistication, in price if not quality, in the past. If this provision were modified in this particular case it is hardly probable that any great harm would result, but the precedent set by such an alteration of the law might very well lead to other changes which might be actually harmful.

Chemical Warfare

A year ago in an article similar to this one the situation with respect to chemical warfare and the protocols under consideration at Geneva were discussed in some detail. The situation since that time has not altered materially. The consideration by the United States Senate of the Geneva protocols was delayed until too late for consideration during the last session of Congress. A determined but wholly misguided effort to endorse these provisions outlawing the use of chemical methods in war is expected to be made when the Senate reconvenes.

Perpetual Motion Again

An account of this kind would be incomplete without the mention of what has every appearance of being the greatest hoax in years. One Garabed T. K. Giragossian, who first commanded public notice during the war years with a device which he claimed would make energy out of nothing in quantities and at costs undreamed of, prevailed upon Congress to pass a bill to protect his invention during its investigation by a group of experts, the Patent Office having previously declined to grant its protection. Perhaps there is nothing especially noteworthy in that, for Congress has been taken in before, but when the investigation of the device was made it proved to be nothing more than a complicated method of driving a heavy flywheel by a very small motor! The flywheel, naturally, was able to store up the small increments of energy supplied to it by the motor, and their sum, when recovered from the moving flywheel, seemed to be far too great to have come from so small a source. Thus, one may hope, ends an amusing and somewhat exciting public adventure into perpetual motion.

Surface Perfection—Surfaces so flat that any deviation from perfection is too small for measurement have been produced by the Bureau of Standards, and will be this country's final judges in any argument over flatness or straightness.

Three disks made from 10 to 12 inches in diameter and 1.5 inches thick fail to show any places where they are more than 0.0000002 inch from being absolutely flat. Such accuracy means that, magnified until the disks extended from Washington to Chicago, no point except along the margin would be out of absolute flatness by more than an inch. They will not be used for direct comparisons, however, but as master flats for checking the accuracy of the optical disks which are used in the work of the bureau.

These master optical flats are made from clear fused quartz, produced in the Thomson Research Laboratory of the General Electric Company at Lynn, Mass. The product, introduced commercially two years ago, is much harder than glass and expands much less than does glass upon being heated.