

Air Hygiene Foundation of America, Inc.,
4400 Fifth Avenue,
Pittsburgh, Pa.
April 27, 1939.

NOTE TO MEMBERS:

Enclosed is a copy of Mellon Institute's annual report which has just been published and which contains a special section on the work of Air Hygiene Foundation (see page 239). Parts of this section may interest various executives in your organization. May we ask, therefore, that you please bring the material to the attention of your associates? Also enclosed is a reprint of an important article on aluminum vs. silica dust. Extra copies of both reprints are available if desired.

H. B. Meller
Managing Director

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Research at Mellon Institute during 1938-1939*

ESPECIALLY prominent among the institute's recent undertakings has been the inception of researches along a broader front for greater service to science, industry, and humanity. Investigations have been begun in several hitherto little studied fields of engineering materials and mechanical equipment for manufacturing, construction, and transportation. Another feature of the year 1938-39 has been the expansion of work in public health, industrial hygiene and economics, pharmaceutical chemistry, electrochemistry, textiles, plastics, and building technology. Special facilities and apparatus have been furnished for these new investigations.

The institute is the hub of the scientific organizations in the Pittsburgh district, most of which meet regularly in its auditorium. National conventions held during the year in the institute's home included those of the American Association of Anatomists, Special Libraries Association, Insulation Committee of the National Research Council, Air Hygiene Foundation, and the Society of Rheology.

General Information on the Institute's Researches

The 86 industrial fellowships—30 multiple and 56 individual fellowships—in operation during the institute's fiscal year March 1, 1938, to March 1, 1939, are listed at the end of this report. These programs of research have required the services of 161 fellows and 96 fellowship assistants during all or part of the year. Thirty-nine fellowships have been in operation 5 years or more, and of this number 20 have been active 10 years, 11 have concluded 15 years or more of research, and 8 fellowships are 20 years of age or older. The institute spent \$1,104,405 in conducting pure and applied science research in 1938-39.

NEW FELLOWSHIPS OF 1938-39. Seventeen fellowships began operation during the year: Acid Recovery, Draft, Electrodeposition, Ethanol, Felt, Filter, Gypsum, Iodine, Meter, Pearl, Printing, Rubber, Silk, Special Dyes, Special Plastics, Tube, and Watch Technology. Four other fellowships have been accepted and will start work soon. Brief accounts will be presented here of the research progress to date of those new fellowships whose establishment has been announced previously. In addition, information will be included regarding the electrodeposition, iodine, and pearl fellowships. On the fellowship on special dyes, at the end of the year, G. B. Feild replaced W. E. Holland as the incumbent; the latter then joined the donor's organization in a technical capacity.

PREVENTION OF STREAM POLLUTION BY WASTE PICKLE LIQUORS. The fellowship on acid recovery of the American Iron and Steel Institute (W. W. Hodge, incumbent) was founded last summer to try to solve the problem of preventing stream pollution by waste pickle liquors. Concerted efforts are being made to improve existing methods and to evolve new ones so that eventually a technically and economically satisfactory process will be developed for the treatment of spent pickle liquors, to obtain from waste liquors chemical by-products and to discover uses for them, and to produce from the acid waste liquors an effluent which will be neutral in reaction and satisfactory to public health and industrial authorities.

The work of the fellowship has included a survey of manufacturing operations and methods in use for the treatment and disposal of spent pickle liquors in important steel-producing districts of the country. Preliminary studies have been made of 35 proposed, patented, or partially industrially developed processes for the treatment of waste pickle liquors, and detailed investigations are being conducted on a few of the most promising procedures. Already, in three of these processes, decided improvements have been effected, and in two other processes engineers and chemists are working on suggested changes of likely benefit. A series of experiments is well under way on possible uses for a material recoverable from spent pickle liquor, and plans are being made to carry on an investigation on the utilization of pickle liquor and its chemical by-products. The quantity of waste pickle liquors produced by the iron and steel plants of the United States has been variously estimated at from 500,000,000 to 800,000,000 gallons per year. Hence the development of suitable processes for the treatment of this immense quantity of industrial waste and the discovery of uses for the recoverable by-products are indeed important. The iron and steel industry is determined to clean up as soon as possible this source of stream pollution.

RESEARCH ON ELECTRODEPOSITION. On the fellowship of the Standard Steel Spring Co., R. H. Lester has a broad program of investigation on electroplating of metals to produce corrosion resistance. In particular he will study the new electroplating process of the donor and will investigate its application in various fields. This process can give a plating of a pore-free type that has been found to be corrosion-resistant, especially in oil wells. The deposit can be made malleable and to withstand abrasive as well as corrosive attack. Steel plated by the novel process has likely markets in the manufacture of pipe, tanks, barrels, special containers, and apparatus.

IMPROVEMENT OF AIR FILTERS. Last fall the American Air Filter Co., Inc., set up a fellowship for the investigation of materials of value for the construction of filters for air-conditioning systems. F. F. Rupert, the incumbent, is giving special attention to the chemical treatment and coating of steel wool and other filter materials to provide the greatest degree of durability and efficiency.

BASIC RESEARCH ON GYPSUM PRODUCTS. The fellowship held by H. E. Simpson is investigating for the U. S. Gypsum Co. the fundamental chemistry of plaster technology as related to the properties of the various products manufactured basically from gypsum and calcined gypsum. The objective is the development of new processes and techniques which will have wide application in the field of building materials.

IODINE RESEARCH RESUMED. During the period January 1, 1928, to January 1, 1933, the Iodine Educational Bureau, Inc., sustained a series of fellowships in the institute whose purpose was to extend the uses for iodine. In the course of this investigational work G. M. Karns, the senior fellow, first studied the effectiveness of iodine in the control of smut on oats and, in cooperation with veterinarians, the place of iodine in veterinary medicine. He next carried out a comprehensive research on the behavior of iodine solutions at liquid-solid interfaces, from which came new knowledge respecting the wetting power of iodine from various antiseptic solutions and also a new iodine antiseptic. He then collaborated in an extra-

mural pharmaceutical study of iodine solutions for antiseptics, devised apparatus for use in the determination of iodine in very low concentrations, and participated in a thorough investigation of the value of iodine for livestock in central Pennsylvania, conducted at the Pennsylvania State College.

Early in 1939 the Iodine Educational Bureau again became a fellowship donor, having decided to support scopeful investigation on uses of iodine in industry, animal husbandry, and pharmacy, and F. F. Johnson has initiated this project.

STUDIES IN METER TECHNOLOGY. The Pittsburgh Equitable Meter Co.'s fellowship on meter technology, with R. L. Wakeman as the incumbent, is investigating the applications of synthetic resins and plastics as constructional materials for gas and liquid meters.

Modern expansion in the use of industrial gases, the development of new products, such as propane and butane, and increased attention to materials balance and utilization of meters in establishing this balance have confronted the producer and consumer of these gases with circumstances which often make it desirable to replace leather diaphragms of meters with materials more suitable to the respective conditions. This need has been recognized for several years by the American Gas Association, as witnessed by the existence of an association committee to study meter diaphragms and the active participation of L. M. Van der Pyl, of the Pittsburgh Equitable Meter Co., on this committee. The meter fellowship, with his collaboration, is pursuing a comprehensive investigation of the properties of synthetic materials which may be useful for this purpose.

Within the past two or three decades, the necessity for meters in the production and marketing of various liquid commodities has increased in proportion to the expansion of the chemical, petroleum, brewing, and other industries, and the demand for meters to handle hot water and other hot liquids in industrial establishments has also grown enormously. This widened use of liquid meters and the increase in exacting requirements placed upon them make desirable a search for new materials of construction. The current vigorous development of the chemistry and technology of synthetic resins, coupled with the versatility of their properties and applications, suggests many new uses for them in the design of fluid meters of all types. With such applications in view, the meter fellowship is undertaking an investigation of the behavior of plastics under adverse conditions which may in the future become standard metering conditions. As the dimensional tolerances in meters are necessarily lower than those in most other articles in which plastics have heretofore been utilized, special methods have been developed for measuring heat resistance, deformation under load, and dimensional change in various liquid media, and an attempt is being made to correlate these and allied properties with the chemical nature and thermal history of synthetic plastics.

NEW KNOWLEDGE ON PEARLS. The members of Pearl Associates, Inc., representing the leading retail and wholesale dealers in natural oriental pearls in the United States, established a fellowship, with A. E. Alexander as the incumbent, to gather complete scientific data on all pearls originating in margaritifera mollusks.

Microscopic studies of thin-sectioned pearls by the fellow have revealed that not all pearls are composed of the orthorhombic variety of calcium carbonate (aragonite). Several large natural salt water pearls on

* Abstract of the Twenty-Sixth Annual Report of the director, E. R. Wendland, to the trustees of the institution.

sectioning have been found to be formed in part of the much commoner hexagonal form of calcium carbonate (calcite). Discovery of the presence of calcite in natural salt water pearls proved important when subsequent experiments were conducted on the use of optical and x-ray equipment as a means of distinguishing cultured from natural pearls. The Japanese cultured pearl has been shown to possess a large core, which, in representative specimens, averages from 75 to 90 per cent of the total linear diameter. This finding is at variance with implications in published statements generally accepted by the buying public as valid. Another phase of the fellowship research has involved testing equipment in use to distinguish cultured from natural pearls, to find methods whereby this equipment could be improved. A case in point is x-ray procedure, employed for many years for pearl differentiation, which has been modified to yield information on pearl substance quickly and accurately. The chemical, physical, and optical tests performed on pearls and the data obtained will form the basis for a comprehensive report. The work completed so far has demonstrated the superiority of the natural pearl in esthetic quality and homogeneous structure over all pearls made by artifice.

RESEARCH IN WATCH LUBRICATION. The Elgin National Watch Co. founded a fellowship for the study of chemical aspects of technical problems in the watch industry, with G. E. Barker as the fellow. The first objective is the development of improved watch lubricants. The lubricant being sought must be nonvolatile, nonspreading, noncorrosive, and chemically stable; it must possess the proper viscosity, pour-point, and solidification temperature, and must lubricate satisfactorily. Special methods have been developed by the fellow for measuring these properties. Among such accomplishments have been the design and construction of an instrument for evaluating the "oiliness" of watch lubricants. Particular attention has been devoted to a correlation of the desired properties with chemical composition. These studies have led to an intensive investigation of many synthetic organic chemicals, which have been learned to possess certain superior qualities over the older, commonly employed animal, fish, and mineral oils. Promising results have been obtained with some of these new products in actual watch tests.

COMPLETED FELLOWSHIP RESEARCH PROGRAMS. The following fellowships concluded their investigations during the year: Dairy Technology, Drying, Flavoring, Food Container, Glazing, Household Utilities, Pharmaceuticals, and Stone. There follows a description of the general activities of and the development of "Thor" products for foundry use by the fellowship on dairy technology. Then there will be given the present status of flaked coffee, a creation of the food container fellowship. The principal research accomplishments of the fellowships on pharmaceuticals and stone have been published.

NEW PRODUCTS FROM SKIM-MILK SOLIDS. Industrial uses for milk ingredients offer a solution to the large problem of profitable disposal of dairy wastes and by-products. Though there is very little outright wastage in the processing of milk, there is a large amount of material which finds its way into feed markets as an expedient for quick disposal. Treatment of such milk products to yield industrially useful articles has been one objective of the dairy industry for a number of years. Casein glues and plastics are already well established in commerce. Additional outlets for milk by-products were the objectives of the fellowship sustained by the Borden Co. from October 1, 1931, to

January 1, 1933. The scope of this program was such as to include for investigation the several types of material obtainable from milk—namely, casein, lactalbumin, and lactose, and the combinations thereof occurring in skim milk and whey. The several projects were carried to varying stages of development.

A new application of the adhesive properties of milk proteins is seen in the development of a line of materials for foundry use. Three products, protected by patents, marketed in dry form under the trade name "Thor" by the Borden casein division, have been made available: a core binder, a core paste, and a silica wash, the latter for employment in steel foundries. Adaptability of milk proteins to these uses has resulted through the discovery of means of solubilizing and rendering effective the otherwise insoluble proteins. High adhesive strength, resistance to moisture, and unique burning qualities of these materials have enabled the formulation of products possessing features of special importance in foundry molds and cores. The research included some new measurements of properties of foundry binders, pastes, and washes. Simplified methods were devised for evaluating these products which bear on their employment in practice.

H. K. Salzberg, the holder of the fellowship throughout its life, was promoted to the donor's technical staff in Bainbridge, N. Y., on January 1, to participate actively in the further development and commercial introduction of "Thor" products.

FLAKED COFFEE. In 1934 the food container fellowship of the Continental Can Co. announced the production of flaked coffee, obtained by rolling freshly roasted and ground coffee [see *News Ed.*, 12, 141 (1934)]. Flaked coffee offered to the consumer a better balanced cup of coffee and a greater economy in the use of coffee, because the flaking operation, by thoroughly crushing the cells, renders their contents more readily accessible for extraction. This economy, in fact, amounts to a 50 per cent increase in the number of cups of coffee per pound. Flaked coffee has been available for three years in packages, but its use has been limited to the brands so packed. The latest development is a counter flaking mill for the retail food market, whereby any coffee, according to the customer's selection, may be flaked to order. This flaker will also be useful in the hotel or restaurant kitchen. Coffee so processed has the same brewing characteristics as packaged flaked coffee, and it is believed this new development will greatly extend both the popularity and availability of coffee flakes.

Bibliographic Statistics

During the calendar year 1933, 17 bulletins, 27 research reports, and 43 other papers came from the institute. Twenty-four United States patents and 38 foreign patents on fellowship inventions proceeded to issue. The total publications for the 28 years ended December 31, 1933, have been 20 books, 174 bulletins, 803 research reports, and 1225 miscellaneous articles; 714 United States patents were granted during the same period.

Announceable Progress in Continued Industrial Fellowship Researches

USES FOR ANTHRACITE. Completely automatic heat is readily obtained with Pennsylvania anthracite, without the necessity of any attention for weeks at a time. This result is secured by using a stoker which withdraws anthracite from the bin, burns it under thermostatic control, and drops the ash by gravity into an ash-storage pit beneath the heater. The multiple fellowship of Anthracite Indus-

tries, Inc. (H. J. Rose, senior fellow) has made engineering studies and prepared designs for modern anthracite bins that set new standards of convenience, cleanliness, and appearance. Completed bulletins give working drawings, construction details, and estimates for gravity ash-removal methods.

In many cases, anthracite ashes may be used to advantage by the householder, for it has been found that they improve the texture and tilth of clay soil. The ashes also reduce soil cracking and erosion and help plants to withstand droughty conditions. Ashes are thought of simply as a soil-amendment agent and not as a fertilizer. Research on uses for anthracite ashes and colliery refuse for the manufacture of building materials has continued with interesting results, particularly in the field of heat-insulating materials.

Data were collected on the inherent chemical and physical properties of anthracite and on its combustion characteristics. A study of the potential smoke-producing tendencies of coals of various ranks was completed.

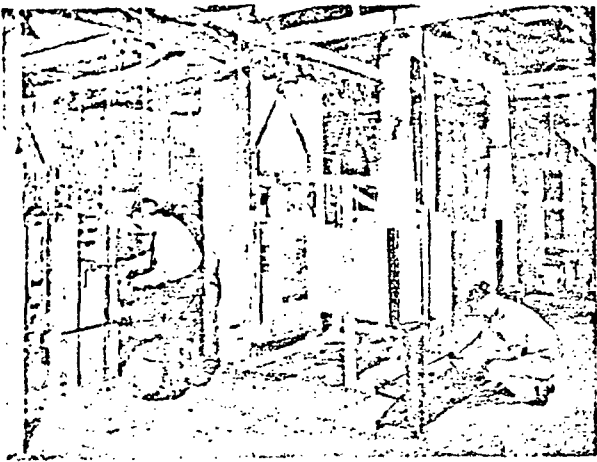
"CALCONITE" IN DAIRY CLEANING. In consequence of laboratory and large-scale work conducted by the multiple fellowship of Calgon, Inc. (B. H. Gilman, senior fellow), the use of "Calgonite" was found to be advantageous in the cleaning of dairy pasteurizers, heat exchangers, and storage tanks, as well as in the washing of cans and bottles. The large-scale investigation of can and bottle washing was supplemented by a bacteriologic study which yielded further confirmation of the sanitational value of film-prevention in cleaning processes.

Now in progress are researches on the constitution of sodium metaphosphate and on the role of sodium metaphosphate in plant nutrition.

CHAINS AND ELECTRIC WELDING RODS. In 1936 the McKay Co. established a fellowship for investigating problems of tire and industrial chain manufacture, with D. F. Helm as the incumbent. Later the study of flux-coated shielded-arc welding electrodes, another wire product, was added to the program of the fellowship, which was expanded to a multiple basis with the appointment of J. E. Harris as junior fellow. During 1933 a number of successful welding electrode coating compositions have been evolved by this research group working in cooperation with the donor's laboratories. These products have been carried through the full cycle of development and are now in production. It is planned that researches will be pursued broadly along the lines now under way, including studies of the processes of manufacture and durability of chain products, origination of shielded-arc welding electrodes for special purposes, and investigation of general problems in the domain of welding technology.

COMMODITY STANDARDS. The multiple fellowship of Kaufmann Department Stores, Inc., which is concerned with problems of retail merchandising, has been in successful operation eight years. During the past year the fellowship staff, headed by Jules Labarthe, Jr., has had a program consisting of the following five general branches: pre-evaluation of merchandise offered to store buyers, establishment of specifications and informative labels for own-brand and other staple merchandise items, evaluation of customer complaints about merchandise serviceability or usefulness, rendering technical service to the store maintenance department, and education of salespeople and consumers.

The pre-evaluation of merchandise has been conducted as far as possible according to recognized standard test meth-



Refractories work in the institute's furnace room

ods. Two or more competitive items were invariably compared and the superior merchandise recommended for purchase. Eighty-two specification-standard staple items were added to the list begun two years ago, and the fellows prepared the copy to appear on the informative label for each of these articles. Eight hundred and forty adjustment cases were studied, of which 213 were judged to be justifiable complaints. The most common causes of failure are defective merchandise, poor color fastness, poor color, poor crocking, and inadequate serviceability in lower priced merchandise. The fellows promulgated to the sales staff constructive material on merchandise quality and care, both in the form of written information and by occasional informal talks. The senior fellow addressed nearly 40 women's clubs and other consumer organizations of the Pittsburgh district.

Four of the five phases of the program have become of direct benefit to the consumer. The basis of every evaluational procedure deals with increasing merchandise serviceability, determining the cause of occasional failure to give good service, and providing useful directions on how to judge quality in goods and how to care for them. In this day, when the so-called consumer movement is of such importance to retailers and manufacturers and labeling legislation is so general, the unbiased technical advice of this fellowship is of ever increasing value to the donor and the public.

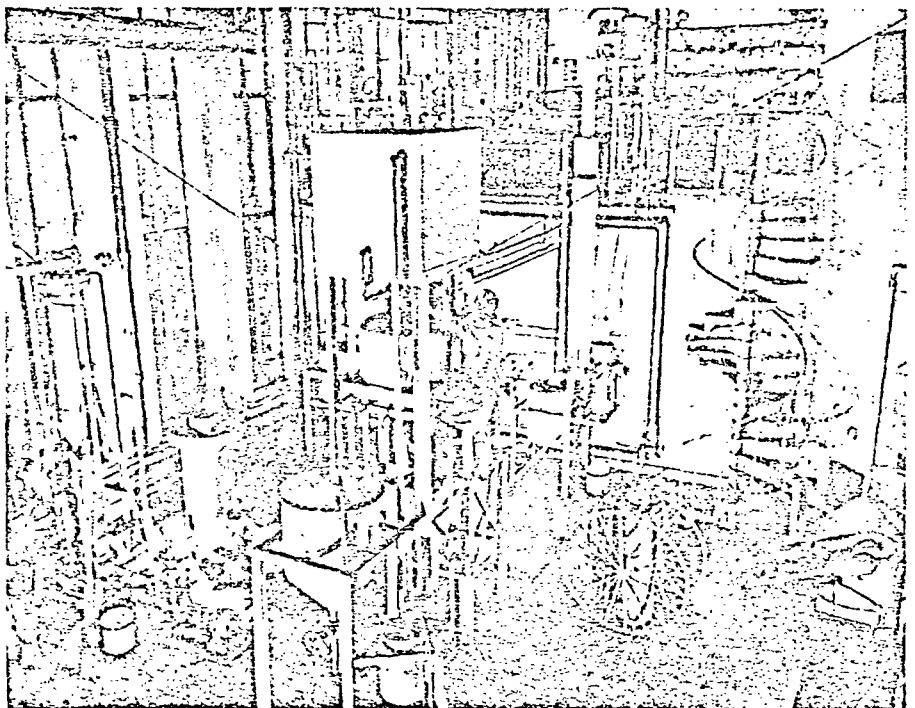
COTTON FOUNDATION FELLOWSHIP. This multiple fellowship—supported by a philanthropic group of business men organized as the Cotton Research Foundation—devoted its first year to a comprehensive survey of the literature on cotton and cotton products and to a laboratory research program for the preliminary examination of potential new uses. The provision of this activity by voluntary contributions from a large number of participants in this commendable movement is worthy of special note. Broadly speaking, the aim is to make both fundamental investigations and practical studies of any subjects that carry the possibility of improving the cotton economy of this country. In order to progress as rapidly as possible, the initial fellowship personnel—consisting of D. M. Musser, R. F. Nickerson, and H. S. Olcott—has been expanded by the addition of five assistants.

A review of the literature on the properties of hull bran and of previous suggestions for its utilization has been completed and submitted for publication.

Moreover, a comprehensive chemical analysis of this material and a spectrographic examination of its ash have been carried out and will soon appear in print. The fellowship has developed a sweeping compound based on cottonseed hull bran that is believed to be more efficient than existing commercial types; considerable interest has been shown in this product, and it is expected that a number of companies will undertake its manufacture in the near future. Problems concerned with the isolation and properties of cottonseed proteins have re-

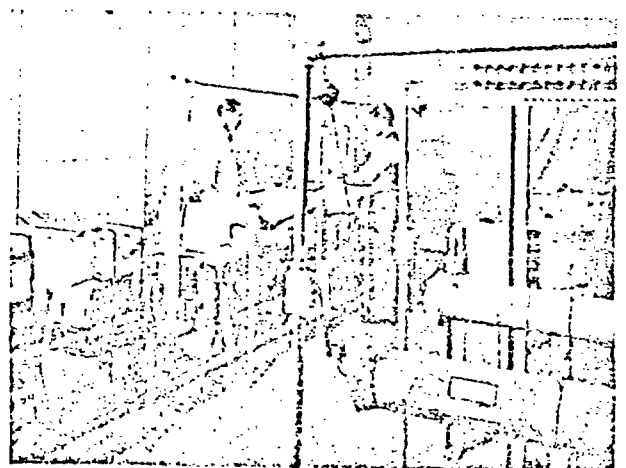
Basic work on the properties of cotton lint relating to certain specialized industrial applications is in progress. Methods of processing and purification of hull linters are being inspected.

The Cotton Research Foundation, continuing its policy of providing financial aid to institutions proposing interesting research projects for cotton utilization, has established, through the agency of Mellon Institute, three fellowships or scholarships in southern universities in addition to that for which arrangements were made at the University of North Carolina last year. This latter problem is an investigation by G. C. Holroyd, under the leadership of F. K. Cameron, of methods of pulping the entire cotton plant to provide an advantageous source of cellulose. At the University of Texas, in a program being supported jointly by that institution and the Cotton Research Foundation, B. B. Allen is studying the products of catalytic hydrogenation of cotton with a view to developing uses for linters and off-grades of lint. W. E. Richards, at the



Unit experimental plant of the Multiple Industrial Fellowship on Organic Synthesis

ceived much investigation. Not only have methods been devised for carrying out the preparation of cottonseed globulin on a pilot-plant scale, but also a number of studies are in progress on possible industrial applications. Another project is an investigation on the possibility of obtaining an effective activated carbon by the thermal decomposition of cottonseed hull bran. The nutritional properties of cottonseed meal of various types are being thoroughly studied by means of growth experiments with rats.



A research laboratory of the Multiple Industrial Fellowship on Heat Insulation

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Texas Technological College, is determining and examining the constituents of cotton burrs. A fellowship, of which R. A. Sutherland is the incumbent, on the utilization of cotton-seed hull bran as a source of lignin and furfural, has recently been put in operation at the University of Tennessee. Realizing that economic aspects are of vital significance in the development of new uses, a novel departure is seen in the fellowship on cellulose economics at the University of Pittsburgh. G. D. Bieber, whose undergraduate and preliminary graduate training has been in the field of chemistry, in addition to pursuing a curriculum of studies as a candidate for a higher degree in the department of economics, will correlate the results of the investigative activities with analyses of the economic situation in cotton technology.

NEW FOODS. The major accomplishment of the multiple fellowship on food varieties of H. J. Heinz Co. (E. R. Harding, senior fellow) has been the complete technological development of a line of special foods for the feeding of children beyond the strained foods age. These new products are the result of a demand from physicians and mothers for foods for young children that are of tender texture and require chewing, afford good nutritive balance with special emphasis on the content of vitamins and minerals, are of easy digestibility and free from spices and other unsuitable ingredients, and have interesting variety and appealing palatability. These foods are also particularly suitable for convalescents and other adults on special diets who need easily digestible foods of high nutritive value. Nine of these foods have been put into production in the donor's factories and three others are ready for manufacture. Most of these products are composed of a number of ingredients combined according to new and unusual recipes planned especially for food factory adaptability. Many problems had to be solved in preparing, cooking, packaging, and sterilizing these foods in order to preserve flavor, color, and food value to the most favorable degree. The twelve varieties include vegetables, both plain and creamed, meat products, fruit, and puddings. Specifically, the names adopted for this line of "Junior Foods" are Creamed Green Vegetables, Creamed Diced Vegetables, Creamed Tomato and Rice, Creamed Diced Potatoes, Lamb and Liver, Chicken Farina Vegetable Porridge, Chopped Spinach, Chopped Carrots, Chopped Mixed Vegetables, Pineapple Rice Pudding, Prune Pudding, and Apple-Fig-and-Date Dessert.

The nutritional studies of the fellowship have been carried forward, and vitamin assays have been completed on most of the junior foods, as well as on several strained foods. A new variety in the strained foods line—namely, strained pears and pineapple—has been developed and put into production following the establishment of its nutritive value.

SURFACE HARDNESS OF GLASS. The term "hardness" admits of no explicit definition; it is indeed generally used without regard to definition, bringing thereby confusion rather than clarity into many statements. Hardness may have as many meanings when applied to glass as when applied to other materials. But, as one of the specific advantages of glass is its ability to transmit light, attempts have been made by the multiple fellowship on technical glassware of the Corning Glass Co. (R. R. McGregor, senior fellow) to determine the ability of different compositions to resist surface alteration of a type that would reduce direct light transmission. Methods and apparatus have been developed that enable the appraisal

of surface hardness according to that point of view. It has been found that this surface stability has not necessarily any relation to the structural stability or mechanical strength of the glass. Attempts are being made to evaluate certain glasses on the basis of the services required of them.

HEAT INSULATION RESEARCH. The multiple fellowship of the Philip Carey Co. (R. H. Heilman, senior fellow) has been active in making thermal conductivity determinations on low-temperature or building insulation. A study of the thermal and physical characteristics of various heat-insulating cements has also been conducted. Considerable time has been expended by the fellowship in experimental investigations leading towards standard methods for determining the thermal and physical characteristics of heat-insulating materials. This work has been carried on in collaboration with various committees of the A. S. T. M.

Since the *Morro Castle* disaster on September 9, 1934, when many lives were lost, stringent specifications have been developed for materials used in ship construction to eliminate the hazard of fire at sea. As a means of preventing the spread of fire on shipboard, it is necessary to have fireproof construction for bulkheads, cabin enclosures, and storerooms, and "Carey Firefoil" has been developed for this purpose. This material, which can be produced commercially in large panels suitable for fire-safe bulkhead construction, is made of alternate layers of flat and corrugated asbestos felts having eight corrugations per inch of thickness. The layers of asbestos felt are joined with a newly developed waterproof adhesive, resulting in a board or panel that is hard, rigid, light, and strong. The 1-inch thick Firefoil core weighs approximately 2 pounds per square foot. It has sufficient strength after soaking in water for 72 hours to withstand a pressure of approximately 75 pounds applied to a 1-inch square die on the surface. Firefoil is manufactured in widths up to 48 inches and can be furnished in any thickness from 1/2 inch up by 1/8 inch increments. The fellowship has assisted in the acquisition of technical information on this new product, which has already found a number of uses other than in ship construction, including boiler and furnace casings, oven walls, casings for air-conditioning units, interior building units, and insulating linings for stacks.

The fellowship has also aided in securing additional technical information on the Carey all-asbestos insulating air duct, described last year, which is having a steadily increasing acceptance in the air-conditioning field.

LABORATORY CONSTRUCTIONAL MATERIALS. "Kemite" and "Karcite," low-shrinkage, acid-resistant ceramic bodies, the pores of which are filled with carbon in the form of coke, conceived and developed by S. M. Phelps, of the institute's refractories fellowship, have kept in large-scale production through the year. These products have been specified for many new laboratory installations, and the reports concerning the ware which has been in use for longer periods have been uniformly favorable. The table tops, sinks, window sills, and drain pipe employed in the institute's building have continued to give excellent service. During the fourth year of the fellowship maintained by the Ceramic Products Co., with E. E. Marbaker as incumbent, prospective new raw materials were evaluated, studies looking towards the development of additional properties were carried out, and new applications were investigated.

MEAT TENDERIZATION. A fellowship was established November 10, 1935, by

the Kroger Food Foundation of the Kroger Grocery and Baking Co. (M. D. Coulter, fellow), for the application of current scientific developments to the solution of naturally occurring problems in the retail merchandising of the meat supply of the country.

Three and a half years of research have culminated in the development to commercial status of a new process making an improvement in the palatability of beef through increase in tenderness and juiciness. The process parallels that long practiced in the "hanging" of beef for periods of 4 to 6 weeks to produce steaks and roasts of high quality and price. By acceleration of the reactions occurring in the beef there are avoided the large capital investment involved in "hanging" beef and the losses due to trimming and shrinkage. In a period of days a tender product of superior juiciness can be produced in the price range of the general market without applying any treatment to the meat other than altering the atmospheric conditions under which it is hung.

Beef is made up of small muscle fibers 1/100 inch in diameter and 1/2 inch long filled with liquid materials containing protein, fatlike substances, and amino acids. These fibers are bound together by a light connective tissue composed for the most part of collagen and elastin. The degree of toughness of beef is caused in major part by the comparative toughness and weight of the connective tissue. Softening or weakening of the connective tissue results in appreciable increase in tenderness. In well-conditioned animals of proper age deposition of fat occurs within the connective tissue, destroying its continuity and weakening it, with the result that the "marbling" of the meat grades is one of the more reliable criteria of excellence. During the "hanging" operation a slow softening of the connective tissue occurs because of the action of enzymes naturally present. At chill storage temperatures (33° to 35° F.) the reaction proceeds very slowly. Increase of temperature accelerates this reaction with the result that, while a period of weeks is required for the desired degree of completion at 33° F., uniform tenderness is attained in 5 days at 55° F., in 2 days at 65° F., and in a few hours at 85° F. Reduction of shrinkage losses is accomplished by raising the relative humidity of the processing and storage coolers to a preferred range of 85 to 90 per cent as compared with the 70 to 83 per cent usually maintained. It has been demonstrated that no deterioration of meat will occur if protection against the exterior attack of bacteria is afforded.

The combination of higher temperatures and a more humid atmosphere presents an ideal situation for the growth of bacteria and mold, and therefore means of overcoming this growth are required. While many agencies for maintaining surface sterility have been long available, no practicable means applicable to this problem had been found prior to the development of the Westinghouse "Sterilamp." In the presence of high temperature and relative humidity it is possible with this lamp to maintain a practical degree of surface sterility on all sides of hanging beef without damage to the carcass or untoward action on workmen constantly employed in the cooler. Ultraviolet sources previously known were not limited in radiation characteristics so as to confine the radiation to bactericidal wave lengths with elimination of wave lengths damaging to organic tissue and fat. In connection with radiation, a slow circulation of cooler air is required and must be of the volume to provide for atmospheric



usual steak cuts employed for broiling and frying are increased in tenderness. The effect is evident in rib and chuck cuts commonly served as roasts. In rounds, the eye, tenderloin tip, and top round are tendered, but results with the frequently flexed bottom round muscles are not uniform. Flavor is inappreciably altered. The juiciness of the beef is greatly increased. "Graininess" is lessened, the presence of individual fibers being undetectable, differing in this respect from originally tender beef that has been neither processed nor hung. The general effect is judged as advancing the beef at least one government grade in general palatability.

The foregoing conclusions have been derived from physical and chemical examinations, submittal of samples to competent authorities in meat merchandising and in culinary art, palatability tests, and consumer acceptance tests on the production of an experimental unit plant over a period of a year and a half.

SCIENCE IN THE USE OF NATURAL GAS. On the Hope Natural Gas Co.'s fellowship (J. B. Garner, incumbent) many problems

change without windburning of the beef or undue loss by shrinkage.

In a practical way it has been found preferable to maintain a temperature of 60° F. in the processing cooler to enable the treatment of the heaviest quarters in a suitable period of time. At appreciably lower temperatures the processing period is unreasonably long and at higher temperatures an extremely accurate control of the time period is required to avoid either "under-processing" or processing to a degree greater than that which is believed desirable for general consumption. Relative humidity is maintained in the previously indicated 85 to 90 per cent range with a gradual replacement of cooler air by conditioned air taken from the outside. A special refrigeration problem was encountered in the design of such a cooler, involving the maintenance of the relative humidity level desired without inducing a too high velocity of air circulation through the conditioning apparatus. Following processing the beef is moved to a chilling cooler maintained at 33° F., where the interior temperatures of the quarters are reduced prior to removal to chill storage to avoid the temperature fluctuations that would inevitably occur with the introduction of a load of beef at the processing temperature. In storage the meat is handled according to present packing-house practice with the exception of atmospheric conditions. In the present case storage is at 35° F. to provide a rigid piece of beef for butchering. Under the conditions of storage a higher storage temperature may be employed with savings on refrigeration costs but it is reflected in less rigidity of the beef for cutting. Ultra-violet radiation is provided during processing, chilling, and storage, and relative humidity is held at 85 to 90 per cent. The latter condition is difficult to attain in the early stages of the chilling operation but is kept as high as possible. The intensity level of radiation is held as low as possible, employing a larger number of lamps at low intensity in preference to a smaller number operating at high intensity.

Application of the new process has been made to the entire beef carcass. The



Upper left-hand. Basic research in the development of a "Junior Food"

Center. View in one of conditioning units in the research on meat tenderizing, showing the "Sterilamps" (upper right) and temperature and humidity recorders (center right). Left to right, H. C. Rentschler (perfecter of the "Sterilamp"), G. D. Beal (the fellowship adviser), and M. D. Coulter are examining a quarter of "Tenderayed" beef

Lower right-hand. A moment of record in a study of the Industrial Fellowship on Chemical Hygiene



having to do with factors in the distribution and utilization of natural gas have been studied. Gas leakage conditions, such as prevail in the streets, alleys, schools, churches, motion-picture theaters, and hospitals in the greater Pittsburgh district, have been surveyed. The application of corrective measures has followed and consequently the hazards of gas leakage have been greatly lessened. Cases of carbon monoxide poisoning, caused by either improper adjustment of appliances or inadequate venting, have had attention. A summary of this investigation appeared in *Pittsburgh's Health*, June, 1938.

Three problems of economic importance have merited the study it has been possible to give them, and further research on a larger scale has been scheduled. Reference is had to inhibition of hydrate formation when natural gas is transported under high pressures and at relatively low temperatures; removal of hydrogen sulfide and organic sulfur from natural gas (tremendous volumes of "sour" natural gas are available for treatment) by a new method evolved by the fellowship which, it is believed, will be more efficient than the procedures now in use; and liquefaction of the hydrocarbons of natural gas and their subsequent separation at low temperatures.

A comprehensive general survey of the entire natural gas industry of the United States has been prepared and is to be published.

ORGANIC SYNTHESIS KEEPS TO THE FORE. The Carbide and Carbon Chemicals Corp.'s multiple fellowship (H. F. Robertson, senior fellow) entered its twenty-fifth year of continuous activity with a unit of the Union Carbide and Carbon Corp. as a donor. During this period of time the manufacture of synthetic organic chemicals has grown to such proportions that it is now one of the important industries of the country, owing largely to the production of an ever increasing number of new chemicals having an expanding sphere of usefulness. In 1938-39 the fellowship has followed this trend by carrying onward the preparation of new compounds on an experimental scale and by investigating possible applications of these compounds and those of others already available. Work has been kept up in the field of amines, and some new derivatives of this class of compounds were found that appear to be of potential industrial importance as textile softeners, wetting agents, and pickling and corrosion inhibitors. Other novel preparations enable the formulation of emulsions under conditions that make the usual emulsifying agents unsuitable. In addition, many application problems involving the use of the now more generally known amines, such as the ethanolamines, ethylene amines, and morpholines, were investigated.

The preparation of new derivatives of diketene and its dimer, dehydracetic acid, has been extended. Some of the compounds prepared are of interest as plasticizers and as pharmaceutical and dyestuff intermediates. Owing to the potential usefulness of diketene as an intermediate in the synthesis of a large number of new materials, a paper, to be published soon, will describe many of the reactions of this interesting compound.

Work was maintained on the preparation of new solvents of the ethylene and propylene glycol series, as were experiments on new uses for those derivatives already commercially available. Industrial applications investigated included the use of these materials as coolants or heat-transfer media, as softeners, plasticizers, or conditioning agents, and as de-

hydration agents of gases. Various problems involving solvents, other than those of the glycol series, were also studied. This work embraced the refining of lubricating oils by solvent methods, degreasing experiments, and many other problems.

The alkyl silicates have continued to be of interest and several of their uses, such as in the formulation of coatings resistant to heat and alkalies, were investigated. Research has also proceeded in the field of vinyl resin coatings with particular emphasis being placed on adapting the commercially available vinyl resins to specific applications. Besides the investigation carried out on coatings, experiments were conducted on other uses for these resins, such as in hot melts.

NEW DEVICES FOR PETROLEUM RESEARCH. In connection with a broad study of the constitution of certain petroleum products, which the multiple fellowship of the Gulf Research & Development Co. (W. A. Gruse, senior fellow) has been carrying on over a period of several years, the need has arisen for quick and accurate measurements of the physical constants of oil hydrocarbons, when only very small samples of the materials are available. To meet this requirement, the development of a series of applicable methods has been undertaken. For viscosity determination, the design of a new type of equipment was necessary. The resulting instrument, although intended primarily for samples less than 0.1 gram in amount, is quite satisfactory for general viscometry. The principle involved is the determination of the rate of fall of a short segment of liquid entirely contained in a longer capillary tube. The apparatus is a small, self-contained, portable unit having an absolute accuracy of the order of 3 per cent, which compares favorably with that of the better instruments now current. The precision, however, is within 0.1 per cent, and a complete determination by an unskilled operator takes only 10 minutes. J. R. Bowman, of the fellowship staff, plans to describe the instrument in a paper in the near future.

The determination of the apparent molecular weight of petroleum oils has always given much trouble, the available methods being either fairly slow and inaccurate or moderately precise while very slow and clumsy. The devising of an improved procedure was taken up by W. E. Hanson and J. R. Bowman, and the result of their study is based in principle on the Cottrell type boiler, employing a Menzies-Wright differential thermometer. No adjustments are necessary and the apparatus is rugged and simple. It is satisfactory for many types of chemical compounds as well as oils, is quite rapid, does not require a purified solvent, and operates with an error of less than 1 per cent. As it is believed the appliance will be quite useful in laboratories of organic chemistry, a description of it will be published.

D. R. Stevens and assistants have completed a basic study of the chemistry of the gasoline sweetening process, by which offensive and harmful sulfur compounds are removed or converted into less objectionable substances, and they expect to report the results shortly.

IMPROVEMENTS IN PRESSING MACHINERY. Among the several fellowships working on problems in textile technology is that of the U. S. Hoffman Machinery Corp. with E. R. Clark as fellow. Maintained continuously since 1928, the work commenced with a study of the effects of heat, moisture, and pressure on wool and silk fabrics. The research was next extended to aid in the design of improved pressing machinery for use by tailors, dry cleaners, and clothing manufacturers.

Better average quality of workmanship and greater production per operator with less fatigue have been attained in several fields, notably in the refinishing of silk dresses after cleaning operations. The extension of the donor's activities into the fields of dry-cleaning and laundering machinery construction broadened the scope of the fellowship, and contributions to the arts involved have been made as to filters and stills for purifying the liquids used and as to complete compact unit plants which permit even the smaller establishments to give high-grade service. A new, safer, and purer type of petroleum naphtha has been widely introduced to replace "Stoddard solvent"—a development for which a former institute fellowship was largely responsible—where fire insurance rates involved in the use of the latter were prohibitive. This naphtha, known as "140-F solvent," is a thoroughly refined, sharply fractionated product with a "Tag" closed-cup flash above 140° F. and an A. S. T. M. end point below 410° F. Despite its high boiling point, it is effectively removed at safe temperatures in special drying devices.

PROTECTIVE COATINGS. The multiple fellowship of Stoner-Mudge, Inc. (G. H. Young, senior fellow) has progressed in investigations on the fundamental structure and properties of organic resin films on metals and other surfaces. Considerable attention has been focused on the mechanism of surface-catalyzed thermal decomposition of halogen-containing thermoplastics, and kinetic studies on such breakdown have led to the development of suitable thermal stabilizers for incorporation in films expected to withstand elevated temperatures. The first of a series of patents covering such stabilized coating compositions has been issued (U. S. Patent 2,130,924). Researches in the field of thermosetting polymers were primarily directed at evolving suitable base-coat primers for use under the familiar vinyl and acrylic copolymers. In connection with these studies, a detailed investigation of the mechanism and reaction kinetics of the phenol-aldehyde condensation has been undertaken. Studies on the nature of metal surfaces, with particular emphasis on the modification of such surfaces by chemical pretreatment prior to coating, have been continued. An investigation of the effect on organic coatings of residual oil and metal soap contamination resulting from improper cleaning of tinplate was successfully concluded, and the necessity for careful control of cleaning operations was clearly demonstrated. Forward steps were made in studies of resin emulsion application to wood, textile, and paper surfaces.

RESEARCH ON REFRACTORIES. In its twenty-second year the multiple fellowship of the American Refractories Institute (S. M. Phelps, senior fellow) provided technical service to the refractories industry by conducting studies for individual concerns and by carrying out researches of broad nature for the benefit of the whole industry. Some of this work has had to do with the development of new test methods for use in controlling the quality of products and for the study of their probable behavior in actual service. Cooperation has been extended to many users of refractories in their problems and in the writing of specifications.

An investigation of general interest has pertained to silica brick, particularly those brick known in the trade as "mottled." In the routine manufacture of silica brick, it occasionally happens that some of the brick as they come from the kiln are discolored in varying degrees. This discoloration occurs as small spots, or may increase in size to large blotches which may cover over half the surface of the

brick; it may vary from a light brown to dark reddish brown. Manufacturers have studied this behavior from time to time, but no reliable remedy has been brought forth. Although there are no records that such brick are inferior to the more appealing cream-colored product, nevertheless some consumers have taken the attitude that they would not give comparable service. Because of this fact it was decided that the fellowship should compare the two types of brick in all their properties. The information obtained from this research shows there is no significant difference between the colored and normal brick. It has long been known that heating a discolored brick in a neutral or oxidizing atmosphere to a moderately high temperature will cause the discoloration to diminish or to disappear, which indicates that it is caused by some material which is oxidized by the aid of the heat treatment. Petrographic examination has demonstrated that the darkened areas are caused by iron oxide in solid solution in the calcium silicate glass which forms the bond of the brick. This iron is present in both the normal and mottled brick, and the state of oxidation is responsible for the color. In view of this finding, differences in physical properties of the two types are not to be expected, especially because the total amount of iron in any silica brick is very small.

NOVEL SILICA PRODUCTS. A study of the properties of "Garspar" in ceramic bodies, enamels, and glasses has constituted one of the main projects of the mineral products multiple fellowship sustained by Norbert S. Garbisch and headed by G. J. Bair. Garspar, the new ceramic raw material developed by the fellowship, consists of an exceedingly fine-grained, homogeneous mixture of quartz and processed glass, produced by means of mechanical and chemical treatment which controls both its chemical composition and physical properties. Garspar is being supplied from a large plant designed and built under fellowship direction.

In whiteware bodies, Garspar is used in place of flint, feldspar, talc, and auxiliary fluxes. It increases the workability of the plastic body, adds whiteness and strength to the fired ware, has a long vitrification range, shows no overfiring at cone 13, improves glaze fit, and decreases moisture expansion of the body.

A new dustless batch-preparing process has been developed by the fellowship for compounding Garspar in glass and enamel batches. The outstanding characteristics of the new batch are complete homogeneity, good heat conductivity, quick melting and firing, absence of dust, and no danger of segregation during handling. An experimental unit has been erected and is being operated by the fellowship.

"Garbond" and "Gartex," in various grades, are some of the new products developed by the fellowship during 1938. Garbond is being successfully used in foundries as an admix to molding sands and as a mold wash. Gartex is a special filler material, surface-processed to obtain proper wetting by organic solvents.

PROGRESS IN STEEL WIRE AND TUBING TECHNOLOGY. The fellowship of the Pittsburgh Steel Co. has been interested primarily in problems in the manufacture of steel wire, and since 1927 many developments in processing suitable for high-specification materials have been accomplished by S. A. Braley. In 1937, D. E. Fabeck was added to the personnel of the fellowship for the express purpose of studying steel wire for the manufacture of coated electrodes. This work has progressed rapidly and much information on the equilibria existing between the steel base and the flux coating placed thereon

has been obtained. In the last two years stainless wire has been added to the line of products of the donor and the principles of carbon wire technology have been applied to the manufacture of stainless steel wire with beneficial results. Recently considerable time has been spent on problems of manufacturing seamless tubing with the aim of increasing quality and decreasing production costs. Specifications, finishes, corrosion, and coating problems, as well as development work on paperbacked building fabrics, are the subject of continuing studies.

NEW USES FOR SULFUR. The investigation of plasticized sulfur has been conducted for the Texas Gulf Sulphur Co. with emphasis on the evaluation of both plasticized and ordinary types of sulfur cements. P. V. McKinney and associates on this fellowship have cooperated with the A. S. T. M. in outlining a program for the standardization of such tests.

Traffic reflectors and other markers are readily set in highway surfaces by the use of sulfur-jointing compounds. The sulfur composition which was used as a filler in the construction of brick roads is in its fourth year of service; it can now be prepared at less expense. This type of material is also under trial for the jointing of glass blocks for skylights. Washing machines in which the tub and rim section are joined with a sulfur cement are now in the tenth month of consumer test. The properties of many porous materials are greatly changed by impregnation with sulfur. Sandstone imbued with sulfur has proved to have superior qualities as an abrasive in a special application. For a similar use abrasive aggregates have been bonded with sulfur cement. Water absorption of both sandstone and stoneware has been eliminated and the swelling of wood greatly reduced by impregnation with sulfur. Tough, pliable packaging materials have been produced by lamination of paper products with plasticized sulfur.

URBAN AIR POLLUTION—A NEW INVESTIGATION IN PITTSBURGH. During 1938 the fellowship on air pollution control cooperated with the Department of Public Health of the City of Pittsburgh in a study of municipal air contamination. The program was carried on under a federal government grant and it is expected this project will be continued through 1939.

A sootfall survey is being made on a more elaborate scale than the studies of 1912-13, 1923-24, and 1929-30. Instead of 12 to 20 stations, there are 100 stations for the collection of precipitated solids and 50 field men who make direct observations of smoking chimneys. Data are tabulated according to the type of plant—heavy industrial, light industrial, commercial, and domestic. There are approximately 5000 stacks in the classes regulated by the city's antismoke ordinance. There are 154,000 dwelling units, 119,000 of which burn coal for fuel, and none of them is subject to smoke regulation. Indications are that the dwelling units are the greatest source of air pollution in Pittsburgh during the winter months. At several points the air is being sampled for the purpose of measuring suspended solids. Established methods are used for comparison with results from instruments developed by the group of specialists associated with the project. The new instruments are designed to give continuous records of suspended solids. The results may be recorded in terms of density as with the Owens automatic filter, by obstruction of light as indicated by photoelectric cells, or in particles counted under a microscope. A spectroscope was built for the study of sunshine. Visible light, near ultraviolet, and far ultraviolet are recorded separately.

Meteorological data obtained from the U. S. Weather Bureau are compared with the records of sootfall, suspended contaminants, and sunshine.

The study of autopsy material is being continued at Singer Memorial Laboratory in the effort to determine possible effects of air pollution as noted in Pittsburgh in causing or aggravating respiratory diseases. In connection with this work and with the cooperation of the Dairymen's Cooperative Sales Association, Milk & Ice Cream Salesmen, Drivers and Dairy Employees Local No. 205, 100,000 questionnaires on the effects of smog were distributed to homes in the city. The Pittsburgh newspapers and radio stations aided actively in bringing this questionnaire to the attention of the public—assistance that was of great value in stimulating returns. The answers have been tabulated and will be appraised by medical specialists.

Investigational Advances of Air Hygiene Foundation of America

Historian J. T. Adams has observed that "Today people are thinking to a very great extent—some of them entirely—of what a corporation is doing for the general social good." The 250 corporations affiliated with Air Hygiene Foundation have contributed to the welfare of their approximately 1,000,000 workmen, and therefore to "the general social good," through the work and accomplishments of this organization during 1938-39. Air Hygiene Foundation is a nonprofit, science organization with headquarters and a multiple fellowship at Mellon Institute. It represents a collective effort by employers in behalf of employee health. The foundation, in addition to its pure, fundamental research in industrial health, provides member companies with practical, plant applications to prevent industrial illness and to foster industrial hygiene.

During the year the foundation's preventive engineering committee, headed by Philip Drinker, of the Harvard School of Public Health, prepared and issued eight bulletins detailing chemical and engineering measures for safeguarding occupational health. These publications, covering a wide range of current, everyday plant problems, are as follows: "Determination of Benzol Vapor in the Atmosphere," "Use and Care of Respirators," "Determination of Chlorinated Hydrocarbon Vapors," "Design of Exhaust Hoods," "Design of Duct Work for Exhaust Systems," "Determination of Lead in the Air," "Identification of Industrial Dusts," and "Routine Sampling for Control of Atmospheric Impurities."

Each month the foundation issues a digest of latest pertinent literature on industrial hygiene, thereby keeping its member companies constantly posted on progress. Approximately 1000 separate articles were abstracted during the year. An exhaustive legal study covering "Compensation Legislation—A Critical Review" was completed and released early in the year, as were the full proceedings of the 1937 meeting. Two information circulars were produced. A number of special articles, describing activities of the foundation, were published in medical, engineering, and management journals.

Meanwhile, under research grants from the foundation, scientific investigations progressed at Mellon Institute, Harvard University, the University of Pennsylvania, and The Saranac Laboratory.

Various well-indicated, short-time studies are conducted at the institute under the supervision of H. B. Meller, senior fellow. Plant surveys and special investigations are being made almost continually for member companies through the founda-

tion's laboratory in the institute. Also through its headquarters here the foundation serves as a central agent for the collection, correlation, and dissemination of data on industrial health subjects. This useful function helps curtail costly duplication and aids in orderly advancing our frontiers of knowledge.

Two graduate fellowships were established by the foundation at Harvard University to investigate engineering problems. These fellowships will train men in industrial hygiene and help build up a skilled personnel to meet the increasing demand for specialists from industry and government. One fellow will study fundamentals of hood design for control of gases and vapors where low velocities are permissible. The other fellowship will relate to the identification and distribution of dusts in tissue.

The preventive engineering committee advises that

The question of "what is the best apparatus and method for dust determination?" is still about where it was a year ago. The Bureau of Mines has shown that the impinger is inefficient for collecting lead fumes in air and suggests the use of an electrical precipitator. The Bureau of Mines has described a midjet impinger which is run at a few liters of air per minute, instead of 1 cu. ft. (28.3 liters). This equipment, very light and entirely hand operable, may gradually replace the large impinger, especially for work in mines. The various grab samplers are helpful, particularly for routine control.

S. R. Warren, Jr., of the University of Pennsylvania, has reported on research in roentgenography being supported by the foundation which seeks to improve x-ray techniques for industrial purposes, as in large-scale medical examinations of groups of workmen. He and his associates experimented in taking parallel x-ray pictures on paper and film, and showed their results to 35 of the country's leading roentgenologists. These pictures revealed all stages of chests from normal to advanced forms of lung lesions. The experts were asked if the paper pictures were adequate for diagnosis and their answers were analyzed in order to prepare the groundwork for standardization of roentgenographic procedure in industry. According to Warren,

It is apparent from the data so obtained that paper roentgenograms may be used for survey work if the technique is at least equal to that used in the tests and if means are available for following up suspicious cases by the use of stereoscopic roentgenograms on x-ray film. This conclusion is qualified by the fact, noted by most of the men who examined the films, that x-ray film has a wider range of density than x-ray paper. In conclusion, the results of this survey are interpreted in terms of the practical procedure necessary in industrial survey work.

L. U. Gardner, director, The Saranac (N. Y.) Laboratory, has disclosed his findings in a study of "mixed" dusts and "protector" dusts which he is conducting under a foundation grant. His experimental data support the thesis that various minerals associated with silica tend to inhibit its action upon the body. While many substances may act as inhibitors, not all are equally effective. When the proportion of silica reaches 50 per cent or more of the mixture, prolonged contact with the tissues may ultimately cause fibrosis. Early observations of metallic aluminum and the hydroxides of aluminum and iron indicate that each of these substances may be more potent in protective effects than numerous other minerals examined in the tests. He added:

The data suggest that analysis of the rock being worked does not necessarily constitute a measure of the silica hazard in a particular industry. When more evidence has been analyzed it may be found practical to use the proportion of silica in the atmosphere as the basis of state codes. It is hoped that the modifying influences of other dusts may also be established upon a practical basis.

The principles involved in these studies probably explain the variations in the rate of development of silicosis in different industries. Ultimately they may make it possible to neutralize the effects of silica upon the body. At present their influence is not sufficiently understood to be used in this manner. In the writer's opinion the major objective in the campaign against silicosis is still the elimination of silica dust from the working atmosphere.

T. C. Waters, of Baltimore, chairman, Maryland Occupational Diseases Commission and member of the foundation's legal committee, has commented on present legal trends as follows:

Twenty-one states have laws compensating disabilities arising from occupational diseases. The laws already enacted have given rise to various controversial questions affecting the relationship of employers and employees. Their present and future administration will create further problems.

The subject of time lost by industrial workers because of disabling illness, and the economic need for the prevention of such illness, with its attendant financial loss to employees, are of vital importance. As disabilities caused by those diseases which we call "occupational" are far less numerous than those caused by the other common ills of life, it is a matter of concern to industrialists today that occupational disease laws should not be administered as general health insurance laws, to provide compensation for time lost by employees owing to common ills.

The 1939 sessions of the legislatures will enact new laws relating to this subject or amend laws now effective. Careful consideration should be given to this legislative program. These laws are the result of definite economic need to afford to employees adequate compensation for injuries they have sustained during the course of their employment. At the time of enactment employers were concerned about the additional cost to which they would be subjected, but to date it does not appear that the laws now effective have placed an unjust burden upon industry. It is too early to predict whether or not the administration of the laws presently enacted will be successful; but if they fail to accomplish the purposes for which they are designed, they should fail because of their inherent defects and inequalities, and not because of the attempt by employers to avoid the imposition upon them of costs for compensating injuries resulting from operations to which their employees have been subjected.

Further employee health improvement was the theme of the third annual fall meeting of the foundation held at Mellon Institute November 17, 1933, which was attended by more than 200 industrial executives representing companies throughout the country. Besides progress reports on research projects, authorities discussed the social and economic implications of the foundation's activities.

W. E. Hotchkiss, of Carnegie Institute of Technology, former president of Armour Institute, pointed out that, according to competent estimates, 200,000,000 working days are lost annually because of illness, meaning losses of hundreds of millions of dollars to employers and their employees. "The only question about the future of a problem like this," he continued, "is whether it is going to be handled sanely

and constructively, and in a consecutive way based on science, or whether it is going to be handled emotionally and restrictedly and unintelligently."

V. P. Ahearn, executive secretary, National Industrial Sand Association, explained explicitly the interest of industry:

A steady job, decent hours with good pay, is no longer the sole criterion. To that must be added industrial health. It is often characteristic of government that, when it swings with the pendulum, it swings too far and thus aggravates rather than cures. Unwise occupational disease laws have been written, but who can deny that there is an irresistible trend toward the enactment of such laws in every State? Those laws are responsive to the apprehension of employees about health hazards in industry. Industry will do well if it recognizes that fact and meets it intelligently.

This question of industrial health is not the single problem of a single industry. Neither is it an emotional nor sentimental problem. It is a practical problem for industry as a whole to solve. Statutes of themselves will not provide industrial health. As in the case of industrial accidents, industry has always shown a capacity, once it recognizes and confronts a problem realistically, to make steady progress toward its solution. Air Hygiene Foundation presents a useful vehicle through which industry can pool its forces in eliminating or controlling hazards to health in industry.

Other addresses were made at the meeting by E. P. Pendergrass, of the University of Pennsylvania, member of the foundation's medical committee, by R. R. Sayers, U. S. Public Health Service, also a member of the medical committee, and by T. F. Hatch, New York State Division of Industrial Hygiene, a member of the preventive engineering committee.

With the growth of industrial hygiene units in the various states (29 have been established to date) and the work of federal agencies in this field, the foundation has been able to cooperate to a considerable extent in these governmental activities. Publications and data are exchanged and a mutually helpful spirit of collaboration has developed to an encouraging degree. The year has also been marked by heavy requests from the public for information relating to industrial health subjects. The foundation makes every reasonable effort to fulfill such needs for facts. There is an increasing public insistence that the talents of industrial management be directed to a greater degree toward public welfare, as well as toward private enterprise. And there are more and more indications that management is heeding the demand for broadened socio-economic leadership. A concrete illustration is the existence of Air Hygiene Foundation which, beyond its contributions to work-a-day health, reflects favorably upon the progressive policies of those 250 companies and associations supporting this work, which benefits not only the employer, but also the employee and the community.

Results in the Department of Research in Pure Chemistry

CHEMOTHERAPY OF PNEUMONIA. Investigations of chemotherapy in pneumonia, under way in this department (L. H. Cretcher, head) for more than 10 years, have been actively pursued during the period covered by this report. C. L. Butler, Alice Renfrew, Mary Hostler, and Mary Clapp have participated in the publication of papers on the chemical researches involved, and E. R. Mease has been in charge of pilot-scale production and engineering developments. The

study of derivatives of apocupreine has been considerably extended by the preparation of a number of new alkyl and hydroxyalkyl ethers. Certain modified sulfanilamide derivatives which contain quinoline or cinchona substituents have been prepared and studies of other modifications of the cinchona molecule are in progress. Patents have been applied for and some granted, both in this country and abroad, covering the more valuable substances developed and the methods for their preparation. The patents are being acquired in order that proper control may be had over specifications and distribution to the best interests of the general public and not for profit. The department has suffered the loss during the past year of C. L. Butler and Mary Hostler, who accepted positions elsewhere. New members of the chemical staff will be announced later.

To date the biological and clinical studies of the cinchonas under the institute's auspices have been necessarily limited to the pneumonia problem. It is planned to extend their application to other infectious diseases as opportunity offers. Though several interesting and active compounds have been discovered none has appeared to be as generally suitable as hydroxyethylapocupreine (No. 71), a compound which has been mentioned in previous reports and in scientific publications, both chemical and medical. A summary covering three years of clinical experience has just been published by the medical collaborators, W. W. G. MacLachlan, J. M. Johnston, M. M. Bracken, and G. E. Crum. The conclusions reached in this paper are as follows:

(1) The mortality figure in pneumococcal pneumonia in adults during the past year has been greatly reduced in those cases which received hydroxyethylapocupreine.

(2) In comparing the mortality figures of the chemically treated cases, which were of course smaller in number, with the serum-treated cases in Pittsburgh, for the same types of pneumonia during the same period of time, almost identical results were observed. (The drug, however, can be used effectively in all types of pneumonia.)

(3) Hydroxyethylapocupreine has shown no evidence of disturbing vision.

Arrangements have been made for clinical investigation of the material in cities other than Pittsburgh.

Experimental work thus far completed, here and elsewhere, has shown that, in identical doses within the effective ranges, hydroxyethylapocupreine will protect against pneumococcal septicemia in mice better than sulfanilamide and fully as

well as sulfapyridine. These comparative studies are being continued.

NUTRITION AND DENTAL CARIES. The pure research fellowship sustained by The Buhl Foundation, on the relation of nutrition to various phases of dental caries (G. J. Cox, assisted by W. E. Walker, Sara Dixon, and Margaret Matuschak), has made certain advances in techniques and has disclosed some new relationships of food to tooth decay in its work of 1938-39.

As tooth decay is highly variable in its frequency, none but a statistical approach to the solution of the problem of prevention of dental caries can be satisfactory. Obtaining the data necessary for conclusions from any experiment in this field demands the use of a large number of animals—in this case albino rats—and the toil of examining the teeth becomes very time-consuming. During the past year a method of preparing serial ground sections of all the molars of 50 or more rats simultaneously has been developed. This method not only permits rapid grinding but also enables the easy accomplishment of the examination of the teeth and the recording of the findings—tasks that are much more difficult with the usual serial sections. Previous findings of the fellowship have been based solely on cavities observed in teeth without sectioning; now it is practical to make a complete study of the teeth of both past and future experiments.

Research on the beneficial effects of fluorides in the formation of teeth resistant to caries has not been entirely conclusive. Meanwhile there is evidence being accumulated elsewhere to show that children with mottled enamel, as caused by fluoride in drinking water, have increased resistance to dental caries. Analyses by others have demonstrated more fluorine in enamel of sound teeth than in that from carious teeth in the same mouths. Two of three series of experiments by the fellowship have divulged that a minimum content of fluorine in the diet of rats during the formation of the molars leads to diminished resistance to dental caries. A third experiment was inconclusive. But the agreement of the two successful tests with the two lines of evidence cited above, as developed by others, indicates that experimental proof of this function of fluorine can be supplied by the rat technique of the fellowship.

In an attempt to determine what factors in meat confer caries resistance to rat teeth, a series of diets varying in protein content has been fed to rats. No difference in caries susceptibility was noted from diets ranging by 5 per cent steps from 10 to 55 per cent protein. A similar study of varied calcium to phosphorus

ratio showed that in the rat the mother during pregnancy and lactation can provide calcium and phosphorus for good teeth over a wide range of ratio of calcium to phosphorus. On the low ratios, however, mothers and young displayed detrimental effects of the diets so far as body weight was concerned.

Some preliminary experiments have indicated that suppression of saliva leads to promotion of decay. These results are in agreement with observations of others on the relation of supply of saliva and human dental caries.

Researches at the Western Pennsylvania Hospital

Under support of the institute, as recommended by C. B. Schildecker, chemotherapeutic studies with aromatic sulfur compounds have been conducted by R. R. Mellon and his staff of eight, using principally pneumococci and streptococci as infecting agents and rats and mice as hosts. Extended comparisons of effective dosage and protective values have been made with large numbers of animals and numerous compounds. Investigation of the mode of action of sulfanilamide indicates that the compound likely permits the over-production of metabolic products by the infecting pneumococcus or streptococcus, which results in an alteration of the growth rate or growth character of the latter. These results will be the basis for further study. Over and above journal publications, 1938 saw the issue of "Sulfanilamide Therapy in Bacterial Infections," a book that surveys the literature reporting the experimental and clinical studies conducted in this country and abroad.

Fundamental research in bacterial variation, using streptococci and tubercle bacilli, has provided additional experimental evidence that transformations do occur within the present accepted classifications. These findings are being applied both diagnostically and therapeutically as opportunity offers. Host factors, such as fatigue and shock, have been studied in correlation with susceptibility to infections, as well as various forms of therapy which influence a subject's ability to resist infection.

Always supplementing usefully any investigative activity is the contrivance of apparatus which will contribute to the elucidation of the problem. The chief product in 1938 was a microcinematographic apparatus which provides sufficiently high magnifications to record single bacterial cells. This device was put into use late in the year and early test films denote that it will facilitate the study of bacterial growth and variation.

Industrial Fellowships in Operation at Mellon Institute during the Fiscal Year, March 1, 1938, to March 1, 1939*

FELLOWSHIP NAME (WITH FOUNDATION YEAR)	FELLOWS AND ASSISTANTS	FELLOWSHIP NAME (WITH FOUNDATION YEAR)	FELLOWS AND ASSISTANTS	FELLOWSHIP NAME (WITH FOUNDATION YEAR)	FELLOWS AND ASSISTANTS
Abrasives (1930)	A. P. Thompson	Bone Products (1935)	E. P. Barrett	Chemical Hygiene (1937)	L. G. Marini, Jr., as- sistant, from Jan. 16
Acid Recovery (1935)	W. W. Hodge	Bread (1930)	J. R. West, assistant		H. F. Smyth, Jr.,
	A. E. Craig, assistant, from Jan. 27	Calgonizing (1933)	H. A. Kohnman		Jane Sention, assistant
Air Hygiene (1935)	H. B. Meller, senior fel- low		B. H. Gilmore, senior fel- low		Louise Leshe, assistant
	J. F. McMahon	Can (1935)	C. L. Jones, senior fellow	Chromium (1936)	R. T. Scherer, assistant, from Sept. 19
	W. H. Huck, from June 1		R. E. Henry		Marc Darrin
	F. E. Rupert, to Oct. 1	Carbon Black (1927)	W. J. Remington		D. F. Altmier, assistant, from June 1
Air Pollution Control (1928)	H. B. Meller		C. W. Sweetzer, senior fellow, to April 1		Daniel Snyder, assistant, from Mar. 21 to May 26
Amine (1937)	R. V. Rice		A. E. Craig, assistant, to Oct. 15		J. E. Troutman, assist- ant, to Mar. 21
Anthracite Industries (1937)	H. J. Rose, senior fellow	Ceramic Chemicals (1933)	W. J. Baldwin	Cigaret Technology (1932)	C. F. Bailey, senior fellow
	R. C. Johnson				A. W. Petre
	E. T. Selig, Jr.	Chain (1936)	D. F. Helm, senior fellow	Commodity Standards (1931)	Jules Labarthe, Jr., sen- ior fellow
	Miriam Griffith, assistant		J. E. Harris		A. F. Traj
	L. L. Friend, Jr., assist- ant, from July 18		W. A. Seibert, Jr., as- sistant, from Sept. 15		M. S. Morgan
	J. H. Shields, assistant, from Sept. 10				

FELLOWSHIP NAME (WITH FOUNDATION YEAR)	FELLOWS AND ASSISTANTS	FELLOWSHIP NAME (WITH FOUNDATION YEAR)	FELLOWS AND ASSISTANTS	FELLOWSHIP NAME (WITH FOUNDATION YEAR)	FELLOWS AND ASSISTANTS
Cork (1937)	E. G. King R. C. Shairbaugh, assistant, from Feb. 15 F. C. Weissert, assistant, from Feb. 15		A. B. Boese, Jr. H. D. Cogan R. G. Ruark H. G. Goodman, Jr. Helen Wassell C. P. McClelland A. L. Wilson, from Jan. 1 J. M. Russ, Jr., from Jan. 1 D. C. Lewis, from Jan. 1 C. W. Patton, from Jan. 1 C. O. Strother, from Jan. 1 E. C. Martin, assistant T. K. Muher, assistant C. I. Spessard, assistant Richard Shifler, assistant	Protein (1937)	W. K. Schneider G. W. Seagren G. W. Gerhardt, assistant
Cotton Foundation (1937)	D. M. Musser R. F. Nickerson H. S. Olcott C. B. Green, assistant, from May 18 T. D. Fontaine, assistant, from June 6 H. C. Engel, assistant, from July 25 G. D. Beber, assistant, from Sept. 1 C. B. Leape, assistant, from Sept. 15 C. D. Thornton, assistant, from Jan. 5 A. E. Goss, assistant, to May 16		R. T. Hull, assistant Frank Snyder, assistant B. M. Stites, assistant D. E. Francisco, assistant W. B. Brown, assistant D. M. Clarke, assistant, from Dec. 1 B. G. Wilkes, to Aug. 1 Walter Kuras, assistant, to Dec. 20 R. C. Boltz, assistant, to Nov. 30 P. B. Davidson J. D. Alley, to May 6 W. D. Claus G. F. Helz R. A. Stegeman A. E. Alexander W. A. Grusé, senior fellow D. R. Stevens W. P. Ridenour John Melschl J. P. Bowman C. J. Livingstone W. L. Hanson J. E. Nickels C. L. Wolfe, assistant Gustave Sill, assistant J. B. McKinley, assistant S. K. Kapff, assistant, from June 1 R. C. Pauzier, assistant, from Sept. 16 C. W. Statler, assistant, to Aug. 15 H. W. Coles, senior fellow Mary Dodds F. W. Adams, senior fellow Lee Devo J. D. Jenkins H. O. Farr Marion Maclean P. W. Crist, assistant C. A. Bishop, assistant W. G. Andrews, assistant H. R. Letner, assistant H. W. Guenther, assistant P. W. French, assistant Alexander Leggin, assistant R. J. Cowles, assistant, from Oct. 10 H. E. Simpson, to Dec. 15 K. B. McAlpine, to May 16 P. H. Dewey, to May 16 C. B. Becker, to May 16 W. H. Lycan, to May 16 H. H. Douglas, to May 16 L. M. Adams, to April 1 W. R. Moffitt, assistant, to June 6 J. L. Eyre, assistant, to May 16 J. B. Cobb, assistant, to May 16 Turrell Cleman, assistant, to April 1 E. R. Clark M. W. Weiss J. H. Young, senior fellow P. W. Jenkins A. W. Coffman D. S. Hubbell G. K. Dumbauld, assistant G. F. Odum, assistant S. W. McCune, assistant, from Feb. 1 Leroy Thompson, assistant, from Feb. 1 G. H. Young, senior fellow	Raolin (1936)	W. S. Claus, senior fellow W. L. Thompson J. W. Reynolds, senior fellow W. M. Kutz G. A. Webb E. E. Fleck, assistant, from May 16 J. W. McClune, assistant, from June 13 F. F. Fox, assistant, from Apr. 21 to Dec. 1 D. M. Clarke, assistant, from May 25 to Dec. 1 G. H. Eadie, assistant, from June 27 to Dec. 1 Barton Barnes, assistant, from June 27 to Dec. 1 Martin Cernely, Jr., assistant, from July 1 to Dec. 1 R. T. Scherer, assistant to May 15
Cotton Yarns (1925)	C. F. Goldthwait H. L. Reidler, assistant R. G. Goldthwait, assistant, from June 8 to Sept. 4			Rayon (1933)	W. B. Burnett, senior fellow R. O. Denyes W. B. Miller G. E. Alter, Jr., assistant, from Nov. 7 W. R. Scott, assistant, to Nov. 1
Cottonseed Products (1930)	A. W. Harvey	Paper (1928)		Refractories (1917)	S. M. Phelps, senior fellow E. B. Read E. C. Petrie R. W. Limes J. P. Maloney, assistant R. C. Briant G. H. Eadie, assistant, from Feb. 2
Dairy Technology (1931)	H. K. Salzberg	Pasteurization (1936)		Rubber (1938)	D. E. Pearsall E. J. Casselman L. C. Hewitt R. F. Stuewer Tracy Bartholomew N. J. Beaber W. E. Holland F. C. Alexander, assistant, from Sept. 20
Dielectrics (1937)	R. N. Wenzel	Pearl (1938)		Special Plastics (1938)	W. L. Rast
Draft (1938)	K. J. Miller	Petroleum Refining (1911)		Steel (1927)	S. A. Braley, senior fellow D. E. Babcock R. C. Briant P. V. McKinney, senior fellow M. G. Mayberry Winton Brown L. C. Rowe, assistant, to June 6
Drying (1929)	K. A. Fulton Betty Bowser, assistant, from July 5 to Nov. 4			Stone (1934)	W. J. Nelson F. P. Hazlett, assistant, from Feb. 20 H. J. Cibula, assistant, from Sept. 25 to Feb. 18 W. E. Tournay, assistant, to Oct. 3
Electrodeposition (1939)	R. H. Lester	Pharmaceuticals (1922)		Sulfur (1931)	E. B. Koster R. H. Calderwood, assistant W. L. Williams, assistant, from June 14 to Sept. 10
Enamels (1925)	D. G. Bennett	Plate Glass (1936)		Tar Acids (1933)	W. F. Fair, Jr. H. R. Beck, assistant J. L. Keller, assistant, from June 13 to Sept. 3
Ethanol (1938)	H. W. Coles W. E. Tournay, assistant, from Oct. 3			Tar Properties (1937)	R. R. McGregor, senior fellow E. L. Warrick J. W. Jordan, assistant, from July 18 J. E. Troutman, assistant, from Mar. 21 to Sept. 1
Felt (1939)	R. R. Fulton			Technical Glassware (1931)	R. R. Ackley T. A. Wilson, senior fellow E. R. McLean D. F. Menard G. D. Barker
Filter (1938)	F. F. Rupert			Textile Finishing (1931)	
Flavoring (1938)	F. F. Johnson			Thread (1935)	
Food Container (1930)	O. O. Miller, senior fellow J. M. Boyd, to Jan. 1			Tube (1938)	
Food Varieties (1921)	E. R. Harding, senior fellow Helen Wignan L. L. Lachat, from Feb. 15 W. C. Bell, assistant Fred Peelor, assistant, from June 20 to Aug. 16			Watch Technology (1938)	
				Yeast (1935)	J. J. Enright, senior fellow H. E. Foote H. W. Walker, assistant Pauline Hopfer, assistant
Garment (1929)	T. H. Swan, senior fellow H. C. Donaldson				
Glazing (1935)	R. L. Wakeman				
Gypsum (1938)	H. E. Simpson				
Heating (1929)	J. L. Young Arthur Veitz, assistant, to Dec. 1				
Household Utilities (1936)	E. P. Breakey				
Insecticides (1917)	O. F. Hedenburg				
Insulation and Roofing (1916)	R. H. Heilman, senior fellow R. W. Ortmiller				
Iodine (1939)	F. F. Johnson				
Laboratory Constructional Materials (1935)	E. E. Marbaker				
Lead (1936)	F. J. Williams				
Meat Merchandising (1935)	M. D. Coulter G. J. Schoells, assistant J. F. McCarthy, assistant, from Nov. 1 R. L. Wakeman				
Meter (1938)	R. L. Wakeman				
Mineral Products (1936)	G. J. Bair, senior fellow R. N. Palmer P. J. Bielski, assistant, from Feb. 1 R. J. Sarraf, assistant, from Feb. 1 T. R. Trevorrow, assistant, from Feb. 1				
Natural Gas (1915)	J. B. Garner				
New Plastics (1933)	J. K. Simons				
Nitrogen Compounds (1933)	P. J. Wilson, Jr., senior fellow J. H. Wells				
Optical Glass (1931)	F. L. Jones I. D. Klein, assistant, from July 5 to Aug. 31				
Organic Synthesis (1914)	H. F. Robertson, senior fellow H. R. Fife				

* Listed alphabetically according to name.