THE MELLON INSTITUTE
OF
INDUSTRIAL RESEARCH

OF

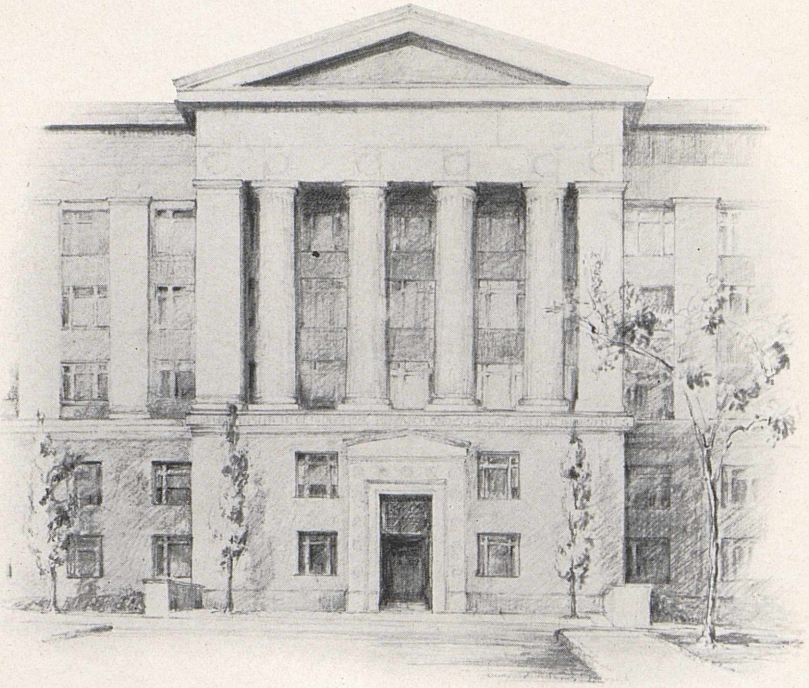
THE UNIVERSITY OF PITTSBURGH

NINTH ANNUAL REPORT

By EDWARD R. WEIDLEIN, Director

PITTSBURGH, PENNSYLVANIA
1922

"To know is to work and to do; and a new thing done is forever a rung in the ladder by which man climbs—necessary and good for all generations, until the summit is attained and the ladder can be cast aside."—*Robert Kennedy Duncan.*



The Mellon Institute of Industrial Research

"This Building is Dedicated to the Service of American Industry and to Young Men Who Destine Their Life-Work to the Industries; the Goal Being Ideal Industry, Which Will Give to All Broader Opportunities for Purposeful Lives."

THE MELLON INSTITUTE
OF
INDUSTRIAL RESEARCH
OF
THE UNIVERSITY OF PITTSBURGH

NINTH ANNUAL REPORT

ON THE INDUSTRIAL FELLOWSHIPS OF THE
MELLON INSTITUTE

By Edward R. Weidlein, Director

For the Institute's Fiscal Year,
March 1, 1921, to March 1, 1922

The System of Practical Coöperation between Science and Industry
Founded by Robert Kennedy Duncan

PITTSBURGH, PENNSYLVANIA
1922

THE Mellon Institute of Industrial Research, in carrying out one of the provisions of its foundation—to disseminate information concerning investigations made—distributes a limited free edition of each of its publications. Copies of reprints of articles cited in this Report may be obtained, when available, by application to the Director, who will also furnish any additional information desired regarding the activities of the Institute. The Institute has published a bibliography of the books, bulletins, research reports, scientific papers, and United States patents of its membership. Copies of this index are sent upon request.

Instruction forms for making application for research positions on the Industrial Fellowships of the Institute may be had from the Director.

CONTENTS

	Page
Officers of Administration	vi
General Information	1
The Growth of the Industrial Fellowship System	5
Some Accomplishments of the System	7
The Publication of Researches	14
Lectures by Specialists Engaged in Research in the Institute	16
The Industrial Fellowship Agreement	18
A List of the Industrial Fellowships	21-23

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THE INDUSTRIAL FELLOWSHIPS OF THE MELLON INSTITUTE

THE Industrial Fellowship System, formulated by Dr. Robert Kennedy Duncan (1868-1914) in 1906, and placed primarily in experimental operation at the University of Kansas in January, 1907, was inaugurated at the University of Pittsburgh on March 1, 1911. In March, 1913, Andrew William Mellon, now Secretary of the Treasury, and Richard Beatty Mellon established the Mellon Institute of Industrial Research on a permanent basis, as a memorial to Judge Thomas Mellon and to Dr. Duncan. Their continued financial support has made it possible to develop the system to its present strong position.

The Institute is a center for technical investigation in chemistry and allied subjects. Its purpose is to promote industrial success through scientific research; in other words, to find new materials and new processes for industrial development and to advance manufacturing through the application of scientific methods to industry. The Institute is a part of the University of Pittsburgh.

The following paragraphs present briefly the working plan of the Institute.

In accordance with the system of research, an individual industrialist, a company, or an association of manufacturers, having a suitable problem or group of problems requiring investigation, may become the donor of an Industrial Fellowship, provided that the problems are of sufficient scope to warrant the services of at least one man for a period of at least one year; and, also, that there is no other investigation in progress in the Institute on the research topic which is of interest to the prospective donor.

The Industrial Fellowships of the Institute are of two general types; viz., Individual and Multiple. An Individual Industrial Fellowship utilizes the services of one research chemist or engineer (with assistants when necessary), who is responsible directly to the executive staff of the Institute. A Multiple Industrial Fellowship utilizes the services of one or more research men (Junior Fellows) under the direction of a Senior Fellow, who, in turn, is responsible to the executive staff.

The Institute is not of a commercial nature, being entirely



The Library of the Institute

independent and deriving no financial profit from the investigations conducted under its auspices. Moreover, members of the executive staff of the Institute devote their time and ability to the interests of the Institute and of the University without outside remuneration.

The donor, on his part, provides a foundation sum which is adequate to cover the annual cost of maintenance of the Industrial Fellowship, which includes operating charges, the purchase of all necessary special apparatus or other equipment, and the salary of the research man or men selected to work on the particular problem, the solution of which is of concern to the donor.

Coöperation by sympathetic encouragement and practical suggestion is also essential on the part of the donating companies or associations for the successful conduct of the Industrial Fellowship work.

The Institute, in turn, selects the Industrial Fellow[1], and the investigation to be conducted is committed to this competent man, who is not otherwise preoccupied during his incumbency of the Industrial Fellowship.

The Institute provides laboratory, library, and consultative facilities, the use of its permanent research equipment, direction to the progress of the work, and an atmosphere which is conducive to productive investigation. All results obtained by the Industrial Fellowship belong exclusively to its donor.

Each Industrial Fellowship is a case of trust, and knowledge concerning its progress and subject matter is withheld from the public, if the donor so desires, in accordance with the terms of the agreement governing its operation (see page 18). Further, the knowledge gained by one Industrial Fellow along one investigational line becomes available to another research man, *provided that such coöperation violates no trust.*

Reports on progress made and difficulties encountered are submitted weekly from each Industrial Fellowship to the executive staff. These private reports are considered for purposes of advice and guidance. Confidential monthly reports are transmitted to the donors, and yearly summary reports are prepared and placed in the archives of the Institute, to be released for publication at such a time as will not injure the interests of the donor. No scientific or technical papers (see page 14) are prepared for publication without the consent and approval of the donor concerned. Moreover, the donor decides as to whether patent protection will be sought for new processes or products developed.

For the benefit of donors, the Institute secures, through proper connections, systematic and prompt advices concerning improvements in American and European technical practice that may be of value in connection with its Industrial Fellowships.

Coöperation is a large factor in the success of the Institute. Teamwork and high creative ability go together, which idea, being made vital by Dr. Duncan, is now a valued heritage of the Institute. The Robert Kennedy Duncan Club is an organization of the In-

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[1] On the procedures used in finding research men, see Hamor, *Science, N. S., 51* (1920), 625. This paper also presents a list of the educational institutions represented by the Industrial Fellows of the Institute.

stitute in which this idea especially lives. All Industrial Fellows are expected to take part in the activities of the Club.

The system of the Institute enables a manufacturer to obtain results in a shorter period of time and at less cost than is ordinarily possible. The coöperative and research facilities of the Institute hasten results.

All advertising or publicity matter referring to the Institute, in which the name of the Institute is mentioned, is by agreement submitted to the Director of the Institute for approval before release.

THE GROWTH OF THE INDUSTRIAL FELLOWSHIP SYSTEM[1]

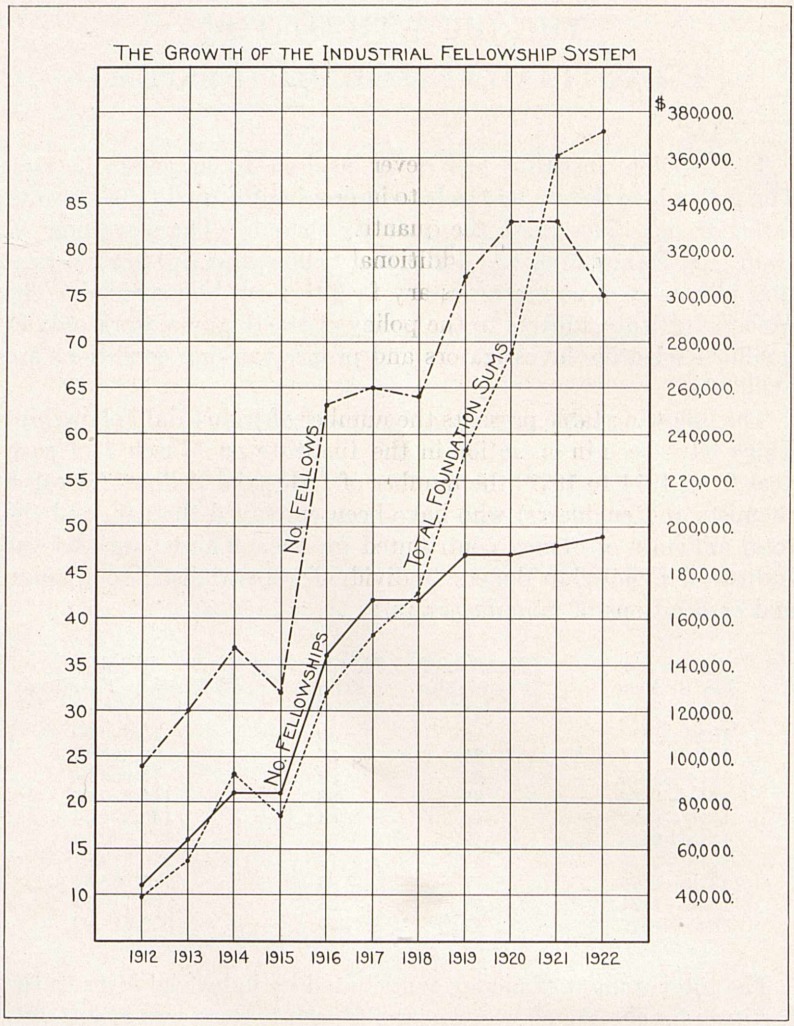
The Mellon Institute has never aspired to largeness in size. The policy is to devote its funds to improving the quality of its work rather than to increasing the quantity thereof. There are now 49 Industrial Fellowships, and additional Fellowships will begin operation just as soon as the necessary facilities can be provided. The Mellon Institute adheres to the policy of starting new work only as qualified scientific investigators and proper working conditions are available.

The following table presents the number of Industrial Fellowships which have been in operation in the Institute on March 1 of each year from 1911 to 1922; the number of Industrial Fellows (research chemists and engineers) who have been employed thereon, and the total amounts of money contributed for their maintenance by the Industrial Fellowship donors (individual industrialists, companies, and associations of manufacturers):

Institute's Fiscal Year	Number of Fellowships	Number of Fellows	Total Fellowship Receipts
1911—1912	11	24	$ 39,700.00
1912—1913	16	30	54,300.00
1913—1914	21	37	92,605.11
1914—1915	21	32	73,902.96
1915—1916	36	63	127,529.08
1916—1917	42	65	153,391.54
1917—1918	42	64	171,990.54
1918—1919	47	77	233,879.27
1919—1920	47	83	275,268.34
1920—1921	48	83	361,140.25
1921—1922	49	75	372,214.99

The total amount of money contributed by industrial firms to the Institute for the eleven years ending March 1, 1922, was $1,955,922. During the eleven years, the Institute itself expended approximately $477,600 in taking care of overhead expenses—salaries of members of the executive staff and office force, maintenance of the building,

[1] For previous reports on the status of the system of coöperation between science and industry in operation at the Mellon Institute, see Duncan, *Science, N. S., 39* (1914), 672; Bacon, *idem, 43* (1916), 453; *idem, 45* (1917), 399; Weidlein, *idem, 47* (1918), 447; *J. Ind. Eng. Chem., 10* (1918), 401; Bacon, *J. Ind. Eng. Chem., 11* (1919), 371; *Science, N. S., 49* (1919), 462; *J. Ind. Eng. Chem., 12* (1920), 716; and *idem, 13* (1921), 478. The *Seventh* (1920) and *Eighth* (1921) *Annual Reports* have also been published privately by the Institute.



purchase of books and apparatus, etc.—in connection with the operation of the Industrial Fellowships. Besides this amount, the building[1] and permanent equipment of the Institute, which make it the most nearly complete and most modern industrial experiment station in the country, represent an investment of about $350,000. In ad-

[1] For a detailed description of the building of the Institute, see Hamor, *J. Ind. Eng. Chem.*, 7 (1915), 333.

dition to these sums, an amount of money now running into several million dollars has been spent by the industries in developing into large scale manufacture various processes worked out at the Institute.

SOME ACCOMPLISHMENTS OF THE SYSTEM

It has been mentioned that the Industrial Fellowships of the Institute are either Individual or Multiple in type. There are now (March 1, 1922) 38 Individual and 11 Multiple Fellowships, which are presented on pages 21 to 23 of this Report; this list indicates the breadth and diversity of the Institute's work. Since only one investigation is carried out on a particular subject at any one time, and since there is accordingly no duplication of the research activities of the Fellowships, there is always a wide variety of different problems under study.

Three of the Industrial Fellowships now in operation (Nos. 277, 290, and 309) have been effectively at work since 1912, while 21 other Fellowships have been promoted continuously for three or more years, and 11 Fellowships are in their second year of operation.

These Fellowships are all well established in their fields of inquiry; and their renewal, year after year, attests to their productivity and to the confidence which their donors have in the Institute.[1] It is of interest to mention here that the incumbents of the larger and older Industrial Fellowships are recognized generally as specialists in the specific branches of technology in which they are carrying out investigations.

The following eleven Fellowships have been founded by associations:

No.	Name	Company-members in Association
282	Stove	14
296	Laundry	1901
297	Wood chemicals	68
301	Fiber	25
306	Insecticides	7
311	Metalware	14
312	Vitrified tile	19
318	Magnesia products	2
320	Refractories	98
322	Cleaning	9
325	Vitrified tile	25

[1] For a list of tributes to the Mellon Institute and its Industrial Fellowship System, see *Chem. Age*, *29* (1921), No. 11, 447-8.



Interior View of a Typical Small Research Laboratory

There are two sizes of research laboratories for the use of the Industrial Fellows of the Institute: twenty-six laboratories, 20 ft. 6 in. x 20 ft. 6 in., and seventeen laboratories, 10 ft. 6 in. x 20 ft. 6 in., have been finished and assigned.

Industrial Fellowships established by associations of manufacturers[1] not only enable the Institute to be of direct service to groups of industrial concerns instead of to individual companies, but their successful operation also gives rise to more stable relations of coöperation among the company-members of these associations by the induction of the reciprocal exchange of experience and research results. The Institute acts as a clearing-house of information

[1] The system in operation at the Institute contemplates that the association shall be limited in each case to those firms in an industry whose interests are sufficiently homogeneous to induce them to pool their resources for the purpose of research.

for donating associations, and gives all the assistance and advice in its power to the company-members. In illustration of this function of the Institute, it may be mentioned that Multiple Industrial Fellowships are supported by the Laundryowners' National Association, the Refractories Manufacturers' Association, and the International Technical Society of Cleaners and Dyers. These Fellowships, which are representative of the others of this general class, serve as technical advisers to the individual members of the donating associations, in addition to conducting testing, standardization and research work of general importance. For the most part, the research has to do with the improvement of industrial processes.

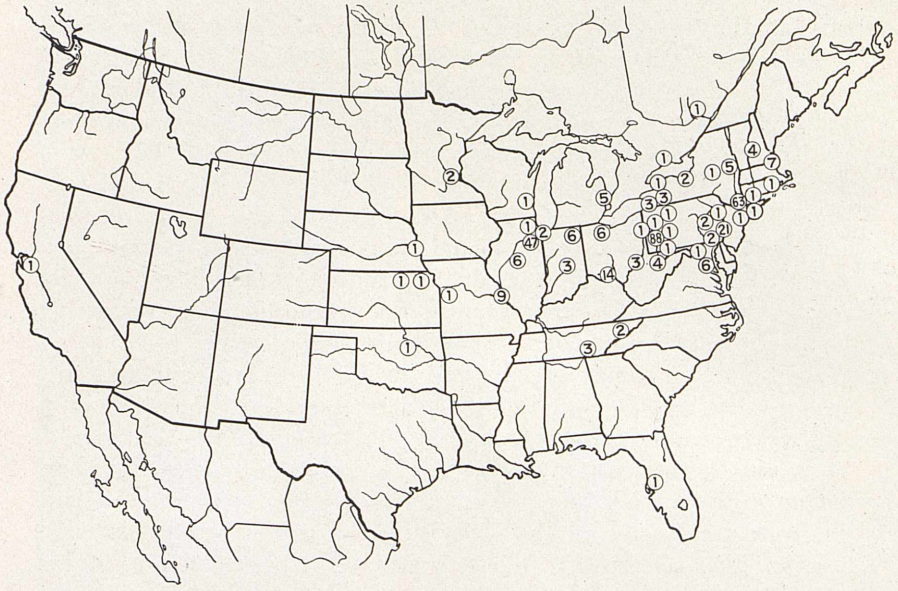
By the application of its system, the Institute has been able to demonstrate to American manufacturers and associations that industrial research, properly carried out, is profitable to them.[1] It would be interesting to give here a statement concerning the financial gains which have been derived by donors as a result of the Institute's activities in their behalf. The executive staff is not privileged to release this information at the present time; but it may be noted in passing that 85 per cent. of the problems accepted by the Institute for study, 1911–1922, have been solved satisfactorily from the donors' standpoints.

The two tables which follow show some of the prominent services of the Institute on behalf of industry.[2]

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[1] For demonstrations of the value of research, see Hamor, *Sci. Mon.*, *1* (1915), 86; *idem*, *6* (1918), 324; and Bacon, *Sci. Am.*, Mar. 17, *1917*, 281. On the scope, objects and effects of industrial research, see Hamor, *Successful Banking*, *5* (1920), No. 12, 8. For a résumé of the types of technochemical problems which have been engaging research attention, see Bacon and Hamor, *J. Ind. Eng. Chem.*, *11* (1919), 470.

[2] See Savage, *Chem. Met. Eng.*, *22* (1920), 249, for a descriptive account of the Institute's investigations on baking, laundering, refractories, dental cements, magnesia insulation, insecticides, protected metals, paper containers, flotation and leather belting. On "How Research Helps Rejuvenate Industries," an article by Arthur Van Vlissingen, Jr., based on the experience of the Mellon Institute, see *Factory*, *24* (1920), 947. Warren Bishop's article on "Research and Everyday Life" (*The Nation's Business*, Nov., *1921*, 20) shows how the Institute has reached the home.



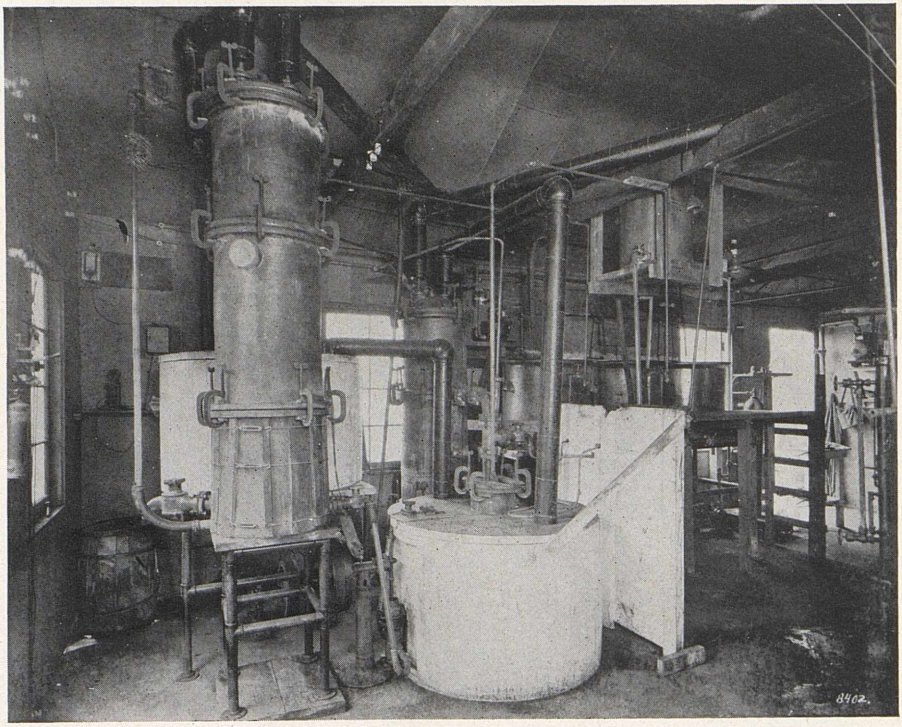
Map of the Activities of the Mellon Institute of Industrial Research

It is the aim of the Mellon Institute to contribute to the progress of the nation by helping to increase the common store of scientific and technical knowledge, and through publications, demonstrations, and the services of specialists to diffuse this information as widely as possible.

The circles on the map show the geographic location and the number of the Industrial Fellowships which have been founded since the formulation of the Industrial Fellowship System in 1907.

NOTABLE INVESTIGATIONS CONDUCTED IN THE MELLON INSTITUTE

Investigations	Industrial Fellows	Years
Physical properties of glass	E. W. Tillotson, Jr.	1911– —
Bread technology	H. A. Kohman and others	1911– —
Citrus products	F. A. McDermott	1912–1913
Electrical precipitation	W. W. Strong	1912–1913
Smoke investigation	R. C. Benner, John O'Connor, Jr., and others	1912–1914
Pressed glassware	S. R. Scholes	1912–1916
Chemistry of petroleum	R. F. Bacon, B. T. Brooks, W. F. Faragher, and others	1912– —
Manufacture of carbon dioxide, carbon monoxide, hydrogen and nitrogen	R. H. Brownlee and R. H. Uhlinger	1913–1915
Composition flooring	R. R. Shively	1914–1916
Fractional distillation	M. A. Rosanoff	1914–1919
Hydrometallurgy of copper	R. F. Bacon, E. R. Weidlein, G. A. Bragg, and others	1914–1920
Olefine gases	G. O. Curme and others	1914– —
Flotation of ores	H. P. Corliss, C. L. Perkins and R. E. Sayre	1915–1921
Dental cements	C. C. Vogt	1915–1921
Chemistry of laundering	H. G. Elledge, A. F. Shupp, and others	1915– —
Natural gas	J. B. Garner	1915– —
Refractories	R. M. Howe	1916– —
By-product coking	F. W. Sperr and others	1916– —
Fiber container	J. D. Malcolmson	1917–1921
Heat insulation	G. D. Bagley and R. H. Heilman	1917– —
Glue	R. H. Bogue	1917– —
Insecticides	O. F. Hedenburg	1917– —
Food and beverage flavors	M. De Groote	1918– —
Inks	F. F. Rupert	1918– —
Protected metals	J. H. Young	1918– —
Sulfur	H. S. Davis	1919–1921
Galvanizing	W. G. Imhoff	1920– —



Interior View of a Unit Experimental Plant

When a new process has been worked out on an Industrial Fellowship, it is developed either in the donor's factory, or, particularly when the process demands apparatus of a novel type which is not available in the factory, a unit plant is built at the Institute. This plant is of such size and it is constructed in such manner that, when it is running smoothly, the donor will feel justified in taking it over and expending such money as will be necessary to put in a very much larger unit or, it may be, several units. A number of unit experimental plants, located on the campus of the University of Pittsburgh, adjoining the Institute, are in constant operation.

NOTED INVENTIONS BY INCUMBENTS OF INDUSTRIAL FELLOWSHIPS

Of 200 technochemical inventions by Industrial Fellows of the Institute, the following are considered the outstanding ones from an economic viewpoint:

Inventions	Inventors	Dates of Patents
Synthetic resins ("redmanol")	L. V. Redman	1914
"Arkady" yeast food	H. A. Kohman, Charles Hoffman and T. M. Godfrey	1915
Glass-making receptacle	S. R. Scholes	1916
Hydrometallurgy of copper	E. R. Weidlein	1916
Flotation of minerals	H. P. Corliss	1917
Shortening composition	H. A. Kohman, T. M. Godfrey and L. H. Ashe	1917 and 1919
Flotation of minerals	C. L. Perkins	1917–1921
Absorbent material	J. B. Garner	1918
Manufacture of enameled ware	R. D. Cooke	1919
Synthetic acetylene	G. O. Curme	1919
Acetaldehyde, acetic acid and acetone preparation	G. O. Curme	1919
Ethylene preparation	G. O. Curme	1919
Recovery of butane and propane	J. B. Garner	1919
Contact sulfuric acid process	H. H. Meyers	1919
Paint or varnish manufacture	F. W. Sperr and Marc Darrin	1919
Dental cement	C. C. Vogt	1919
Gasoline from natural gas	J. B. Garner	1920
Dry lime-sulfur product	O. F. Hedenburg	1920
Arsenate of lead	O. F. Hedenburg and D. S. Pratt	1920
Coating materials	J. H. Young	1920
Adhesive	J. D. Malcolmson	1921
Flotation of minerals	R. E. Sayre	1921
Liquid glue	D. K. Tressler	1921
Protected metal articles	J. H. Young	1921

THE PUBLICATION OF RESEARCHES

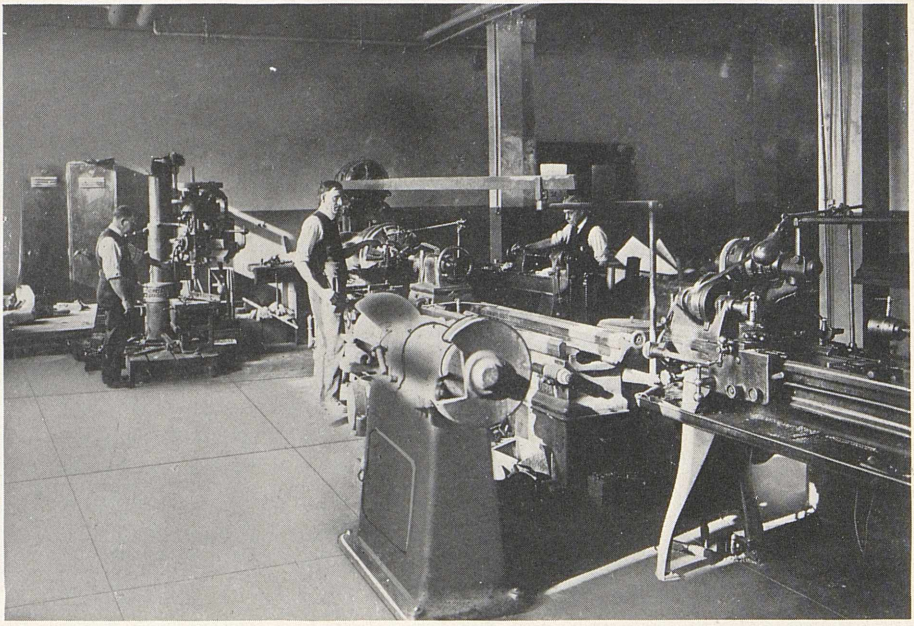
An industrial research establishment must be known by the successful commercial processes which it has inaugurated, and by the published accounts of the inquiries conducted under its auspices. It is of prime importance to the progress of science and technology to transmit as soon as possible after their completion trustworthy records of methods, theories, achievements, and even of errors and failures. In demonstration of this function of the Institute, it seems fitting to present here a list of the contributions from the Institute during the past ten years:

CONTRIBUTIONS FROM THE MELLON INSTITUTE

	Publications During Calendar Year				
Year	Books	Bulletins	Research reports	Other scientific papers[1]	United States patents issued
1912	1	1	15	12	—
1913	—	6	22	15	2
1914	—	3	13	27	10
1915	—	2	10	31	20
1916	2	1	14	18	18
1917	—	1	27	22	40
1918	—	2	21	16	14
1919	—	2	29	25	44
1920	1	1	41	62	11
1921	2	1	40	31	35

The research findings of the Institute's Industrial Fellowships are released for publication in accordance with section 8 of the agreements governing their operation (see page 19). It is now realized by industrialists that the methods of science are the most effective procedures thus far developed for the advancement of technology, and that, accordingly, scientific investigation is an essential economic adjunct to manufacturing enterprises. This understanding of the meaning and value of research, and of the importance of utilizing available and advancing knowledge, has emphasized the perils of ignorance and destructive competition to a

[1] The papers enumerated relate principally to the scope, value, and administration of industrial research, and to the general consideration of technochemical problems.



A Section of the Machine Shop of the Institute

This shop is equipped to produce the various special mechanical appliances required in industrial research.

degree not hitherto attained in the history of industry. It has indicated clearly the necessity for sympathetic coöperation in the exchange of information. The encouragement of research and the recognition of the desirability of disseminating the knowledge gained are indeed among the most noteworthy signs of the times.

LECTURES BY SPECIALISTS ENGAGED IN RESEARCH IN THE INSTITUTE

The renewal of a certain proportion of the Fellowships year after year enables the incumbents to become experts in their particular fields of investigation; and, in order to broaden the training of all the research men, a course of lectures is given throughout each year in the Fellows' Room of the Institute by these specialists who are engaged in research in the Institute. The subject matter presented by the Fellow in his lecture is approved by the donor of his Fellowship. These discourses are of a general nature, dealing with the present status of the various industries, their important problems, and the part played by the chemist in developing these industries. All the lectures are open to the public and to the students registered in the courses of chemistry and chemical engineering in the University of Pittsburgh. In arranging for each series of addresses, the Mellon Institute receives from the University of Pittsburgh the coöperation of the Department of Chemistry of the College, of the Department of Chemical Engineering of the School of Engineering, and of the School of Mines.

The table which follows covers the series of lectures which was prepared for the year 1921—1922:

Date	Lecturer	Subject
October 3, 1921	W. A. Gruse	"The Chemistry of Petroleum"
October 10, 1921	W. F. Faragher	"The Refining of Petroleum"
October 17, 1921	J. G. Davidson	"Pyrolysis and the Motor Fuel Problem"
October 24, 1921	R. B. Trusler	"The Asphalt Industry"
October 31, 1921	C. L. Jones	"The Commercial Possibilities of American Oil-Shales"
November 7, 1921	J. B. Garner	"The Natural Gas Industry"
November 14, 1921	W. J. Huff	"The By-Product Coking of Coal"
November 21, 1921	J. L. Sherrick	"The Technical Importance of Colloid Chemistry"
November 28, 1921	H. S. Davis	"The Sulfur Industry"
December 5, 1921	R. J. McKay	"Nickel and Its Alloys"
December 12, 1921	W. F. Henderson	"Cellulose Products"
January 9, 1922	W. G. Imhoff	"Galvanizing and Its Applications"
January 16, 1922	H. A. Noyes	"The Contributions of the Chemist to Agronomy"
January 23, 1922	R. M. Howe	"Metallurgical Refractories"
February 13, 1922	H. W. Greider	"The Technology of Magnesia Products"

Date	Lecturer	Subject
February 27, 1922	A. F. Shupp	"The Contributions of the Chemist to the Laundry Industry"
March 6, 1922	L. E. Jackson	"The Garment-Cleaning and Dyeing Industry"
March 13, 1922	H. H. Meyers	"The American Fertilizer Industry"
March 20, 1922	O. F. Hedenburg	"The Manufacture and Uses of Insecticides"
March 27, 1922	R. H. Bogue	"The Manufacture and Uses of Gelatin and Glue"
April 3, 1922	R. H. Heilman	"The Conservation of Heat Losses from Pipes and Boilers"
April 17, 1922	M. De Groote	"The Flavoring Materials Industry"
April 24, 1922	H. A. Kohman	"The Baking Industry"
May 1, 1922	C. C. Vogt	"Some Contributions of Chemistry to Dentistry"
May 8, 1922	M. C. Walsh	"The Fiber Container Industry"
May 15, 1922	Walther Riddle	"The Manufacture of Varnishes"
May 22, 1922	F. F. Rupert	"The Manufacture of Inks"

An additional series of lectures on "The Scientific Method Illustrated from the History of Science," by Dr. Walter Libby, was arranged as follows:

Date	Subject
February 14, 1922	"The Scientific Imagination"
February 21, 1922	"The Hypothesis"
February 28, 1922	"Conceptual Thinking"
March 7, 1922	"Induction (contrasted with Deduction)"
March 14, 1922	"Reasoning by Analogy"
March 21, 1922	"The Nature of Cause"
March 28, 1922	"Experiment and Observation"
April 4, 1922	"Scientific Laws"
April 11, 1922	"Social Stimulation of Investigation"
April 18, 1922	"The Suggestive Value of the Industries"
April 25, 1922	"The Genetic Method"
May 2, 1922	"The Mental Characteristics of the Researcher"

THE INDUSTRIAL FELLOWSHIP AGREEMENT

Each Industrial Fellowship which is accepted by the Institute is the subject of a definite agreement between the individual industrialist, company, or association of manufacturers concerned and the Institute. The following is the form of agreement for Individual Fellowships[1] now in use by the Institute:

AGREEMENT FOR.....INDUSTRIAL FELLOWSHIP NO.....

THIS AGREEMENT, made and entered into this..... day of ....., 192..... between Mellon Institute of the University of Pittsburgh, of the city of Pittsburgh, Pennsylvania, hereinafter called the "Institute", and.....
(A Corporation) of.....(having head offices in.....)
.....hereinafter called the "Donor",

WITNESSETH: That, for the purpose of promoting the increase of useful knowledge and in consideration of the mutual promises and covenants herein contained, the parties hereto agree as follows:

1. The Donor shall pay to the Institute (annually) (in.....payments) in advance for a period of ..... year(s), (beginning) on....., 192....., (the date on which work on this Fellowship is commenced), the (total) sum of .....
.....DOLLARS ($.....), for the foundation of an Industrial Fellowship to be known as.....
INDUSTRIAL FELLOWSHIP NO....., the exclusive purpose of which is:.....

.....

.....:

and the study of such other problems connected with the Donor's business as in the opinion of the Director of the Institute can be accepted by the Institute. In case the Donor desires problems other than those specifically mentioned above to be included under this Fellowship, written permission to include such problems shall first be obtained from the Director of the Institute.

2. The Institute shall accept the sums so to be furnished by the Donor and shall devote them as herein indicated to the furtherance of the problems of this Fellowship; to this end, out of the money received from the Donor under this Agreement, the Institute shall pay over as compensation to the incumbent of this Fellowship such amounts from time to time as may be agreed upon by the Institute and said incumbent; and the Institute shall also out of said money purchase such apparatus, chemicals, and other supplies related to this research as the Director of the Institute may deem necessary for its efficient operation, and defray traveling expenses and other expenses incident and related to the elucidation of the problems concerned; and the remainder shall be retained and applied by the Institute toward its reimbursement for expenditures for water, light, heat, gas and other general overhead expenses incurred by the Institute. The Fellow shall be provided, at the expense of the Institute, with adequate laboratory facilities, with the general facilities of the Institute, and with the advice and direction of the administrative officers of the Institute. The Donor, on its part, shall coöperate with the Institute in this research by providing the Director thereof and the Fellow of this Fellowship with its sympathy and with whatever knowledge of the subject of research it may possess, and, with the approval of the Donor, with its facilities for large-scale experimentation. In the event that experimental plant work shall be recommended by the Director and requested by the Donor, such additional expense, including traveling expenses, as may be incidental thereto, shall be borne by the Donor.

[1] This form has replaced the ones described in *J. Ind. Eng. Chem.*, *11* (1919), 371, and in the *Eighth Annual Report*, *1921*, 8.

3. The incumbent of the Fellowship provided hereunder shall be appointed by the Director of the Institute, upon such terms as the Director and he may agree upon, and he shall give his whole time and attention to the object of the Fellowship, with the exception, if the Director so elect, of three hours a week which he shall give to instructional work in the University of Pittsburgh. The Fellow shall work under the advice and direction of the Director and shall from time to time through the Director forward to the Donor reports of the progress of his work. During the existence of the Fellowship provided hereunder, the Donor shall have the right, through and with the acquiescence of the Director, to employ and take into its regular service the Fellow of this Fellowship, upon terms to be agreed upon between the Fellow and the Donor, and the Institute shall appoint a successor to the Fellowship, vacated by reason of the regular employment of the Fellow by the Donor, provided the condition of the research work shall, in the opinion of the Donor and the Director, make necessary or advisable the appointment of such successor.

4. Any and all discoveries, germane to the subjects of this investigation, made during the term of this Fellowship, as well as all relevant information obtained, by the Fellow of this Fellowship, or the Administrative Staff of the Institute, separately or conjointly, shall become the property of the Donor, subject to the terms and provisions of this Agreement, and such member of the Institute making such discovery or obtaining such information shall promptly and without demand make revelation of all such information and discoveries. Such revelations shall be made to the duly designated representatives of the Donor directly, or through the Director, as the Director may determine.

5. The members of the Institute, as referred to in Paragraph 4 of this Agreement, making a discovery or invention germane to the subjects of his investigations shall at any time, upon the request and at the expense of the Donor, apply for letters patent, and shall upon demand assign such letters patent and any and all rights to such invention to the Donor under the conditions of this Agreement. In case the Donor desires to keep secret any discovery or invention, or for any reason desires that letters patent shall not be applied for, such member of the Institute making such discovery or invention shall not at any time apply for patent or patents in his own name and shall not disclose such discovery or invention to others except as herein provided.

6[1]. The Donor shall, in addition to the sums paid to the Institute as foundation for the Fellowship, pay to the Fellow a BONUS. This bonus shall consist of.....

.....

7. In the event of any difference of opinion between the parties hereto as to the interpretation of this Agreement, or the rights of the respective parties to this Agreement, the matters in issue shall be referred to a Board of Arbitration, which Board shall consist of a representative of the Institute and a representative of the Donor and a third person whom these two shall select. The decision of this Board shall be obtained without recourse to the Courts and when rendered shall be binding upon the parties hereto.

8. During the term of this Fellowship, the incumbent thereof may publish such results of his investigation as do not, in the opinion of the Donor, injure the Donor's interests. It is contemplated that on or before....., 192....., the said incumbent shall have completed a comprehensive monograph on the subject of his researches. The subject matter of such monograph shall not contain specific information of the process or methods of the Donor, but it shall be confined to a statement of new discoveries of scientific fact obtained by this Fellowship. A copy of this monograph shall be forwarded to the Donor and a copy shall be signed and placed in the archives of the Institute until the expiration of three years from the time hereinafter provided for the termination of this Fellowship, when the Institute shall be at liberty to publish it for the use and benefit of the public. Such monograph when published shall not contain data or information in regard to the cost of manufacture by any process revealed in such monograph.

In the event that in the opinion of the Donor such publication at such time will unduly injure the Donor's interests, the Donor shall have the privilege of appealing at any time for an extension of time of such publication to the Board of Arbitration provided for herein, which, after considering the appeal, shall, if in its opinion such publication will unduly injure the Donor's interests, extend the time of publication to a time when, in the Board's opinion, publication will not unduly injure the interests of the Donor.

It is also agreed that no advertising or other publicity matter having or containing any reference to the Institute or in which the name of the Institute is mentioned shall be made use of by the Donor

[1] Optional.

or anyone in the Donor's behalf unless and until the same shall have first been submitted to and received the approval of the Director of the Institute.

9. The Fellowship provided for in this Agreement shall terminate on the..... day of....., 192....., (unless renewed, it being understood and agreed that the Donor may renew this Fellowship upon such payments and terms as may then be agreed upon).

IN WITNESS WHEREOF the parties hereto have caused this Agreement to be duly executed under seal the day and year first above mentioned.

MELLON INSTITUTE OF UNIVERSITY OF PITTSBURGH

WITNESS: By.....

.....

DONOR.....

.....

A LIST OF THE INDUSTRIAL FELLOWSHIPS IN OPERATION AT THE MELLON INSTITUTE ON MARCH 1, 1922

No.	Names of Industrial Fellowships	Industrial Fellows, Names and Degrees	Dates of Expiration
181	Synthetic resins	*C. B. Carter* (Ph.D., University of North Carolina), senior fellow	
		A. E. Coxe (B.S., University of Chicago)	April 1, 1922
233	Enameling	R. D. Cooke (M.S., University of Wisconsin)	April 1, 1922
276	Fish products	D. K. Tressler (Ph.D., Cornell University)	April 1, 1922
277	Bread	*H. A. Kohman* (Ph.D., University of Kansas), senior fellow	
		Roy Irvin (M.S., University of Kansas)	
		E. S. Stateler (B.S., University of Kansas)	June 1, 1922
278	Oil-shale	C. L. Jones (M.S., University of Pittsburgh)	June 1, 1922
279	Combustion	J. G. Davidson (Ph.D., Columbia University)	June 1, 1922
280	Protected metals	*J. H. Young* (Ph.D., Ohio State University), senior fellow	
		P. D. Gephart (B.Ch.E., Ohio State University)	June 1, 1922
282	Stove	J. E. Hansen (B.S., University of Illinois)	June 22, 1922
283	Perfumes	J. K. Senior (Ph.D., University of Chicago)	June 15, 1922
285	Food container	W. F. Henderson (M.S., University of Pittsburgh)	
		Adeline Hrubecky (University of Pittsburgh), assistant	July 12, 1922
286	Nickel	R. J. McKay (B.S., University of California)	October 1, 1922
		K. D. Dodds (B.Chem., University of Pittsburgh), assistant	October 1, 1922
287	Metallic oxides	G. E. Seil (M.S., University of Pittsburgh)	September 1, 1922
		C. A. Marsteller (Carnegie Institute of Technology), assistant	September 1, 1922
288	Ester	J. J. Fitzpatrick (B.Chem., University of Pittsburgh)	August 15, 1922
289	Gas	*J. B. Garner* (Ph.D., University of Chicago), senior fellow	
		J. E. Underwood (M.A., Wabash College)	September 15, 1922
290	Oil	*W. F. Faragher* (Ph.D., University of Kansas), senior fellow	
		W. A. Gruse (Ph.D., University of Wisconsin)	
		R. W. Henry (B.S., University of Oklahoma), assistant	September 1, 1922

A LIST OF THE INDUSTRIAL FELLOWSHIPS—*Continued*

No.	Names of Industrial Fellowships	Industrial Fellows, Names and Degrees	Dates of Expiration
290	Oil (continued)	S. P. Marley (University of Pittsburgh), assistant	
		Ronald Reamer (B.S., Allegheny College), assistant	September 1, 1922
291	Glass	R. R. Shively (Ph.D., University of Pittsburgh)	September 1, 1922
292	Silicate of soda	William Stericker (B.S., University of Wisconsin)	September 8, 1922
293	Slag	Tracy Bartholomew (E.M., Colorado School of Mines)	September 21, 1922
294	Phosphorus	E. E. Marbaker (Ph.D., University of Pennsylvania)	October 15, 1922
295	Salt	T. E. Williams (B.S., University of Michigan)	November 1, 1922
296	Laundry	*A. F. Shupp* (Ph.D., University of Pittsburgh), senior fellow	
		Alice L. Wakefield (B.S., Carnegie Institute of Technology)	
		Mary M. Danley (B.S., Carnegie Institute of Technology)	November 1, 1922
297	Wood chemicals	R. F. Remler (B.Chem., University of Pittsburgh)	November 1, 1922
298	Emulsion flavors	Melvin De Groote (B.Ch.E., Ohio State University)	November 15, 1922
299	Varieties	E. R. Harding (M.A., Leland Stanford University)	January 1, 1923
300	Inks	F. F. Rupert (Ph.D., Massachusetts Institute of Technology)	November 1, 1922
301	Fiber	M. C. Walsh (Chem. Eng., Columbia University)	November 15, 1922
302	Pratt memorial	(Industrial Fellow to be appointed)	December 1, 1922
303	Silicate	J. L. Crawford (B.S., University of Illinois)	December 1, 1922
304	Coke	*F. W. Sperr, Jr.* (B.A., Ohio State University), advisory fellow	
		J. W. Hepplewhite, Jr. (B.Cer.E., Ohio State University)	
		W. J. Huff (Ph.D., Yale University)	
		H. J. Rose (B.A., Yankton College)	
		J. A. Shaw (B.S., Pennsylvania State College)	
		G. G. Desy (B.S., Worcester Polytechnic Institute)	January 1, 1923
305	Organic synthesis	C. J. Herrly (B.S., Pennsylvania State College)	
		H. R. Curme (Ph.D., University of Pittsburgh)	
		F. W. Hightower (B.S., University of Texas)	
		F. H. Marley (B.Chem., University of Pittsburgh), assistant	January 1, 1923