science invention and society

the story of a unique American institution

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RESEARCH CORPORATION
A Foundation for the Advancement of Science
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grants programs in the natural sciences

As part of its dual mission to support research in the natural sciences and to help utilize the results of scientific inquiry, Research Corporation conducts four major grants programs:

Cottrell College Science Grants strengthen academic research programs in the natural sciences at private, predominantly undergraduate institutions.

Cottrell Research Grants initiate basic research projects in the physical sciences and engineering at degree-granting institutions.

Brown-Hazen Grants support work directly related to mycology, stressing research, training in mycological research, and medical applications.

Williams-Waterman Grants assist practical programs to combat nutritional diseases, especially in the developing nations of the Western Hemisphere.

In addition to these established programs, Research Corporation considers for support unusual, challenging concepts in its fields of interest.

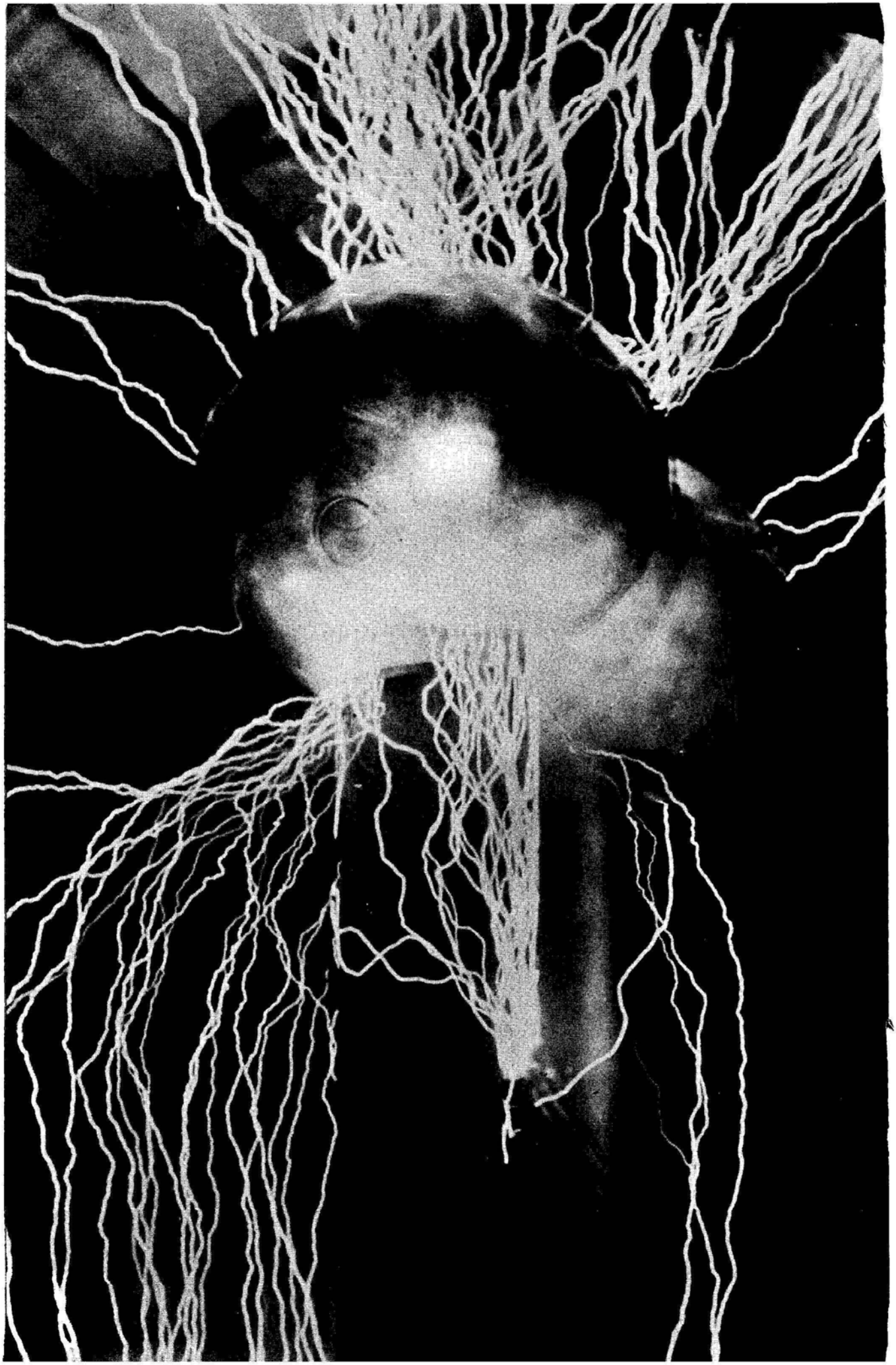
patent programs for institutions

Dedicated to speeding the utilization of useful scientific developments in the public interest, Research Corporation evaluates, without cost, faculty and staff inventions made at colleges, universities and other nonprofit institutions.

Patent protection is sought for promising inventions assigned to the foundation, which bears all normal legal and administrative expenses incurred. Consistent with the public interest, industrial licensees are located to further develop and produce useful products or processes.

Distribution of royalty income from patents is carried out in accordance with institutional policies to reward inventors, to provide funds for institutional purposes, and to assist the foundation's grants programs in the sciences.

On occasion, invention evaluation services are made available to individual inventors where the invention is to be assigned to the foundation and the greater part of any royalties realized is to be donated toward the advancement of academic science.



Spectacular arcs of high-voltage electricity crackle around the terminals of the first large Van de Graaff generator in an initial demonstration in 1933. Constructed in a blimp hangar at Round Hill, Mass., it provided an early tool for nuclear research. The project was aided by Research Corporation grants to MIT beginning in 1931.

a foundation for the advancement of science

SIXTY YEARS have passed since the founding of Research Corporation, but the circumstances which brought it into being are as much a part of today's scene as current newspaper headlines. Inventions designed to control air pollution and promote industrial conservation led to the birth of the organization long before it became fashionable to be concerned about the environment. The inventor-founder of Research Corporation, Frederick Gardner Cottrell, was an idealistic young scientist and teacher who believed in yet another form of conservation: the conservation, development and use of human intelligence.

Dense, noxious smoke poured from the chimneys of turn-of-the-century smelters and other industrial plants in the burgeoning San Francisco area, killing vegetation and making downwind areas unhealthy for humans and livestock alike. Cottrell's inventions, which made possible the electrostatic precipitation of particles from stack emissions, greatly reduced air pollution and, at the same time, often recovered valuable raw materials from the waste gases.

Because industrial gas cleaning could pay for itself by returning useful chemicals, the process was immensely promising and would have earned its inventor a sizable fortune. Cottrell, however, believed that the laws of nature were there to be read by anyone with the time and resources to decipher them, that they were the property of all to be used for the benefit of all. His own inventions would be used to help others discover these laws and apply them to the common welfare.

His enthusiasm won over friends associated with him in developing electrostatic precipitation as a commercial process, and they agreed to his highly unusual suggestion that science should be the principal beneficiary. Among these early

Research Corporation, Frederick Gardner Cottrell, was an

associates were Professor Edmund O'Neill, Harry East Miller, a consulting chemist, and E. S. Heller, a San Francisco lawyer. A later participant was Walter A. Schmidt, inventor of an important improvement in early precipitation equipment.

As a professor of chemistry at the University of California, Cottrell had first sought to donate his patents to existing institutions so that they could use the proceeds to support future research. After futile attempts to persuade any of them to undertake such a program of commercial development, he resolved with the help of the secretary of The Smithsonian Institution, Charles D. Walcott, to form his own institution to put his concepts of scientific philanthropy into practice.

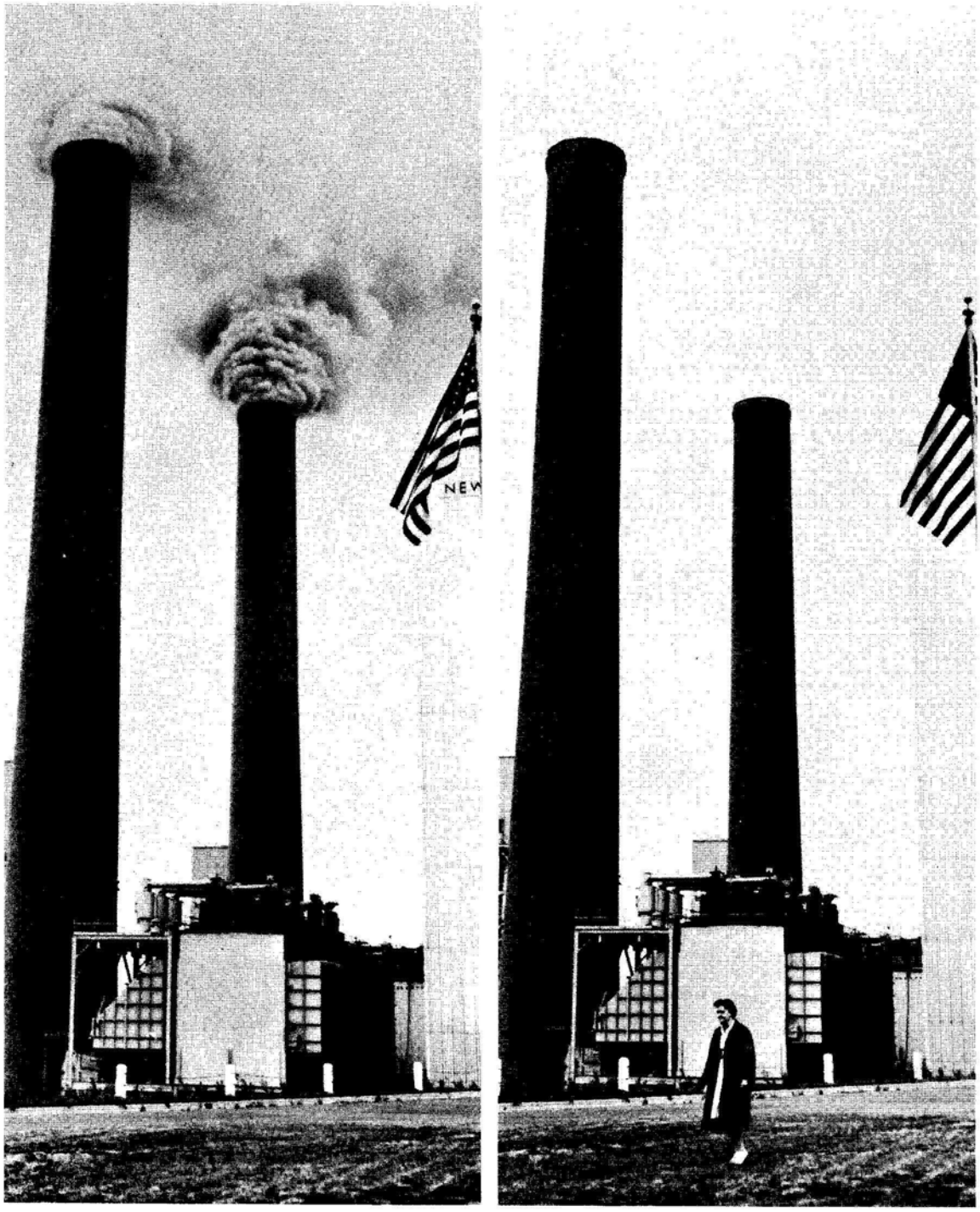
They were highly practical concepts. Fred Cottrell had grown up in modest circumstances as a native of the frontier state of California and a student at its new state university. He had been plagued both by lack of monetary support and difficulty in gaining acceptance for his novel inventions. With incredible energy and dedication he had won through, and in 1912 at the age of 35 he and his associates were ready to aid the progress of other young men and the promising new ideas they might produce.

The year before, Andrew Carnegie had lavished a gift of $10 million on the newly-formed Carnegie Corporation; a year later the Rockefeller Foundation would come into being with a handsome endowment. By way of contrast, Research Corporation, a foundation for the advancement of science, would be endowed only with the potentially valuable patent rights to Cottrell's inventions. Nevertheless, he reasoned that there was so great a need for the organization that it would "prosper from hunger."

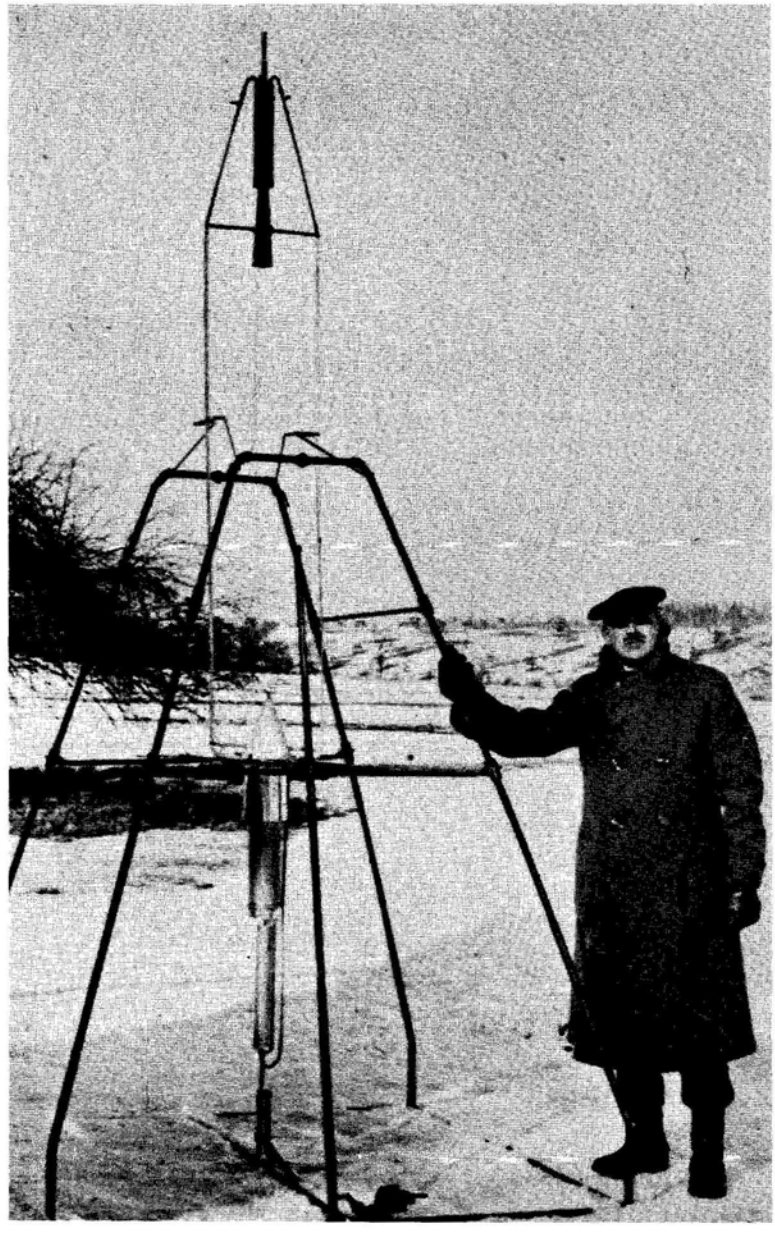
A charter, said to have been drafted by William Howard Taft, was adopted and an imposing Board of Directors assembled with the help of Secretary Walcott. A sale of stock that would never pay dividends provided capital of $10,100, with the directors investing in it from motives which, at the time, could only be described as charitable.

Research Corporation was, as Cottrell intended it to be, a "by-the-bootstraps" operation in its early years. Author Frank Cameron in his biography, *Cottrell—Samaritan of Science,* notes the incongruity of a board of directors that included such industrialists and financiers as T. Coleman du Pont, Otto Kahn,

Fires burn at this power plant, but the smoke vanishes when the electrostatic precipitator at chimney base is turned on (right). Patent rights to the invention, which could remove fly ash, dust and fumes, acid mists and fogs from stack gases, formed the original endowment of Research Corporation. Precipitators, or "Cottrells" as they were generally called, remain a valuable tool against air pollution. Together with other pollution control equipment, they are produced today by Research-Cottrell, Inc., now an independent, publicly-held company.



Funds were scarce for rocket research in the 1920s when Research Corporation grants aided the crucial early experiments of Robert H. Goddard. Here, Goddard stands beside the first liquid fuel rocket to fly (March 16, 1926). Oxygen and gasoline tanks were mounted at the bottom and connected through fuel lines to the nozzle at the top.



George W. Perkins (a retired Morgan partner) and Elon Huntington Hooker scanning a financial report that resembled that of a corner cigar stand.

Royalties from the electrostatic precipitation process were in the offing and within three years all Research Corporation stock was repurchased from the original backers and deposited in the foundation's treasury where it has remained ever since. However, it took nearly a decade of hard work before the infant industry could provide an income great enough to help support the research projects of other investigators. For many years the precipitation business was an integral part of the foundation, becoming a taxable subsidiary in 1954. As Research-Cottrell, Inc., it is now an independent producer of equipment for control of air, water and thermal pollution.

Today, as one of the 25 largest U. S. foundations in annual grants, Research Corporation is only a minority stockholder in Research-Cottrell, deriving the greater part of its income from investments and from royalties on patents donated by public-spirited inventors who followed Cottrell's example.

progress, expansion and change

As some of the potential of the Cottrell patents began to be realized and the balance sheets went from red ink to black, the foundation took its first small steps. In 1917 a fellowship in applied science was established. The first gift to a university was a grant of $5000 made in 1920 for the support of cryogenic work at Harvard.

It was an exciting time for science, and Research Corporation's second decade was marked by—among other developments—a $5000 grant made in 1923 to The Smithsonian Institution to further the early experiments of "the father of rocketry" Robert H. Goddard. Grants remained in the low thousands of dollars between 1923 and 1927, but as the foundation prospered, more funds were spread out among a number of research institutions around the country.

Basic research received contributions of from $23,000 to $96,000 a year between 1928 and 1940. The average of $55,000 a year was made up of a number of individual grants of modest size. Between 1941 and 1945, the average climbed to $140,000 a year, and it would take further quantum jumps upward under the stimulus of postwar developments.

Although Cottrell had forsworn any role as an officer or director of the foundation he had established, he was active as a gadfly, alert to new ideas generated by his own work, his colleagues and by other scientists in government, industry and the academic community. He traveled widely, was well acquainted with researchers all over the world, and was known especially for his ability to spark new ideas.

"Ask Cot," his friends often said. "He may not know anything about your problem, but before you get through talking with him *you* will know more about it."

The gadfly played a role in a number of far-reaching developments. During a visit to the University of California in 1931, Cottrell quickly became enthusiastic about the work of Ernest O. Lawrence whom he characterized as "a man we should keep close track of—young enough and with a sufficiently good early start to go far." The upshot of the visit was a $5500 grant to the university to help Lawrence acquire the giant magnet that was to become the heart of the first large cyclotron.

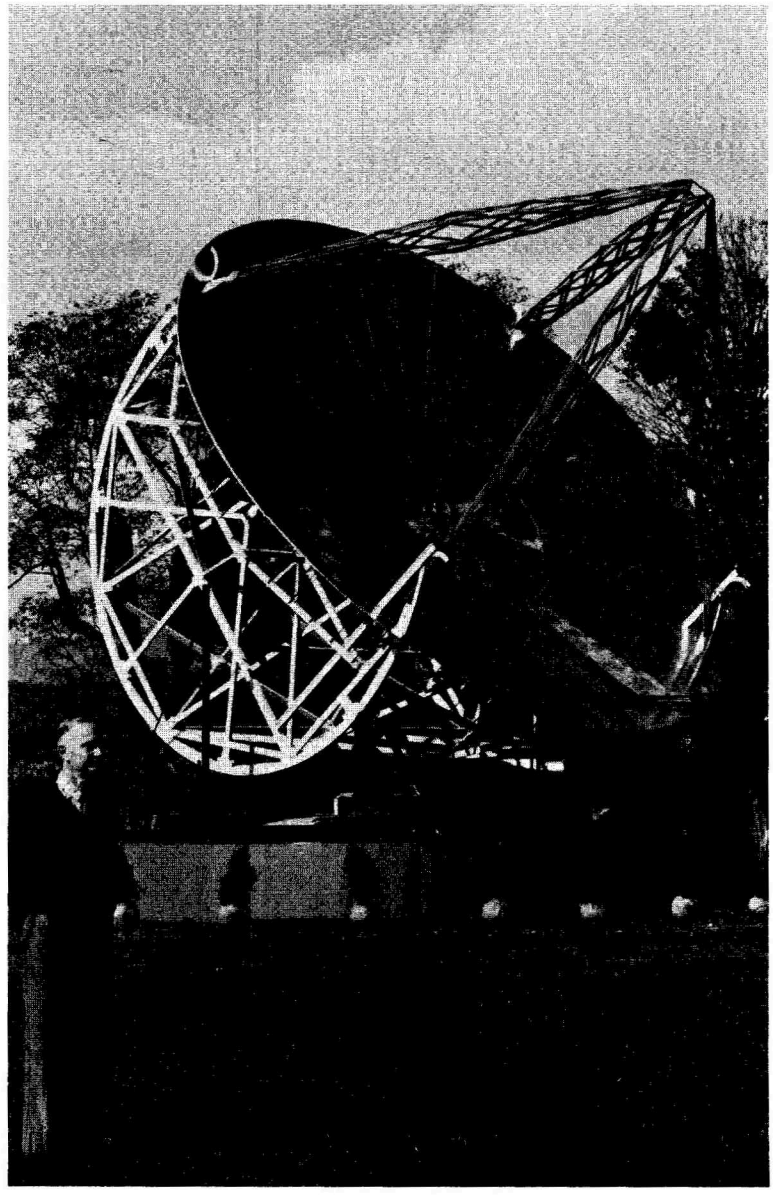
Somewhat later that same year, a grant was made to Massachusetts Institute of Technology to assist the early work of R. J. Van de Graaff, inventor of the high-voltage generator now bearing his name.

Grants continued at an accelerated pace despite the depression, supporting work in physics, chemistry, engineering, mathematics, astronomy and other fields. Although the dollar amounts seem incredibly small by present-day standards, Research Corporation grants helped support initial study, construction and operation of cyclotrons at Rochester, Chicago, Purdue and Columbia.

The nuclear age was dawning even before World War II, for work such as that by Lawrence and Van de Graaff would play a crucial role in splitting the atom. The future could be read in a 1939 report submitted to Research Corporation on work done under yet another grant. It included a reproduction of an oscillographic tracing—one of the first records of energy release in uranium fission.

Research Corporation had become a dynamic foundation, supporting—up to and beyond the limits of its modest income—imaginative research by young men with new ideas. Its initial impetus had come from Cottrell's gift. It was his hope that

The strange hiss of radio noise from outer space, discovered in 1932, led a lone radio amateur to build the world's first radio telescope in his backyard in Wheaton, Ill. The 1937 device, shown at the National Radio Astronomy Observatory where it was later moved, revealed extraterrestrial signals and provided a previously unknown view of the cosmos. Grote Reber, shown here with his invention, helped establish radio astronomy in U. S. through work aided by the foundation.



(1) The mystery posed by the high incidence of beriberi among people subsisting largely on white rice occupied Robert R. Williams (left) for 25 years. Polishing rice to make it palatable removed some vital substance, which Williams and Robert E. Waterman (holding beaker) confirmed was vitamin B_1, then synthesized it. This 1937 photo heralds that success, presages the fight against malnutrition waged with patent royalties.

(2) A bit of soil from a Virginia farm, two women scientists in separate labs, and years of collaborative research—all were elements in the discovery of nystatin, a safe antibiotic against human fungal diseases. Elizabeth Hazen (left) of New York and Rachel Brown (right) of Albany patiently studied hundreds of soil samples for promising microorganisms. The reward: A Virginia sample, collected by Dr. Hazen herself, led to nystatin. The patent was donated to the foundation to aid research.



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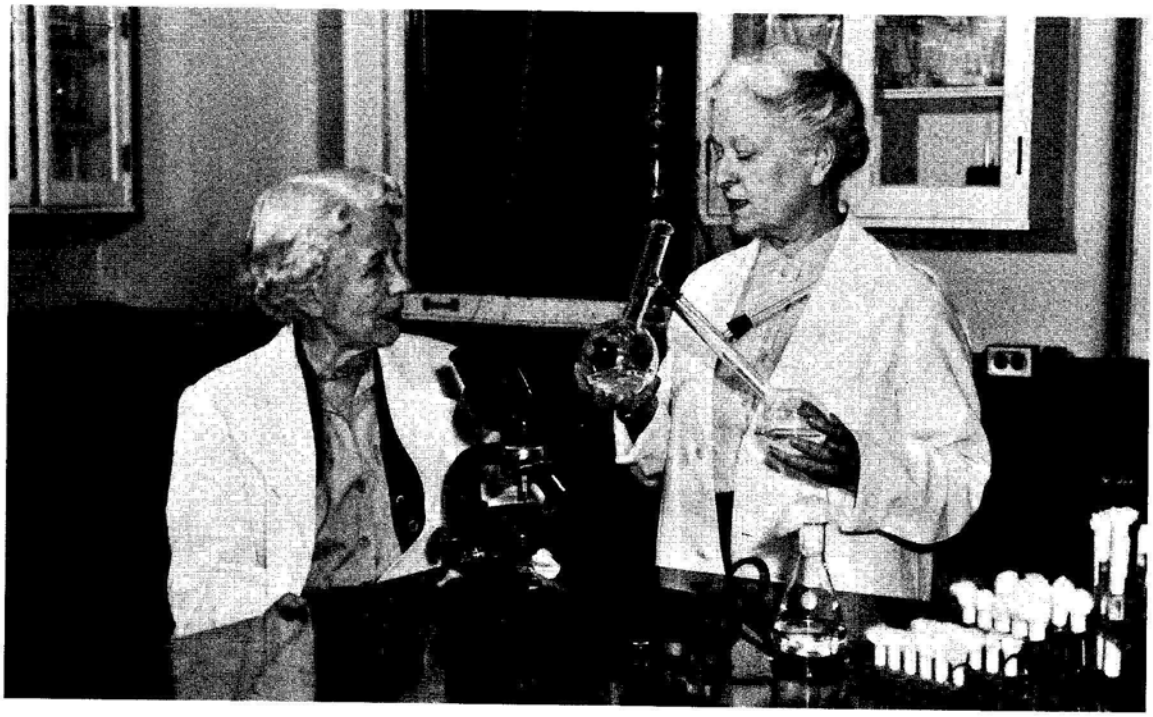

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other public-spirited inventors might wish to contribute their patents and expand his endowment.

Aid from other inventors was indeed forthcoming. Outstanding were Robert R. Williams, Robert E. Waterman and their colleagues who in 1935 assigned their patents on the synthesis of vitamin B_1, or thiamine, to Research Corporation. Beginning in 1942, Edward C. Kendall of the Mayo Clinic donated patents from his pioneering work on the steroid hormones, which ultimately resulted in cortisone. Yet another valuable addition was nystatin, the first successful antifungal antibiotic. This patent was donated in 1957 by Rachel Brown and Elizabeth Hazen of the Division of Laboratories and Research, New York State Department of Health.

applying the fruits of research

The proceeds from these patents and a number of others, added to those originally donated by Cottrell, would provide funds for research, but the foundation was to have another important task. It was also chartered to extract potentially useful ideas from the laboratory and put them to work.

In this Cottrell, a pioneer in industrial conservation, was dealing with the preservation and use of human resources. "The men in our universities and colleges have been among the first and most effective in promoting the general conservation movement," he wrote in a 1912 article for the *Journal of Industrial and Engineering Chemistry*. "Yet there is what we may term an intellectual by-product of immense importance, a product of their own activities still largely going to waste. This is the mass of scientific facts . . . which never, or only after unnecessary delay, reaches the public at large in the form of useful inventions . . ."

Something had to be done, Cottrell maintained. The foundation's 1912 charter spelled it out and a 1932 act of the New York State legislature reaffirmed it. First among the purposes of Research Corporation was that of rendering inventions and patent rights "more available and effective in the useful arts and manufactures and for scientific purposes."

Today, the foundation has invention evaluation agreements with more than 250 nonprofit institutions in the U. S., Canada and other countries. Promising inventions assigned to it are patented and put to work, and royalty income shared with

inventors and institutions. Under these agreements, it administers patents on such developments as the laser, refinements in computer technology, new drugs, industrial apparatus, chemicals, basic inventions in nuclear science, communications equipment, laboratory apparatus, inventions in agriculture, metallurgy and food technology.

realization of an ideal

The end of World War II marked the beginning of a new era. The groundwork for both grants and patents efforts had been laid, and the funds had been earned to permit Research Corporation to play a major role in both areas. Grants and patents programs were formalized and help extended to institutions in many parts of the world. The foundation's close ties with the academic community, long an important feature of its operation, were strengthened.

These ties are maintained in part by grants staff members who function as roving emissaries, making visits to hundreds of institutions and thousands of young faculty members, senior professors and academic administrators. They offer objective opinions on the merits of existing and proposed science programs, evaluate the research climate at each institution, identify promising teacher-investigators and find specific ways in which foundation grants can be productively applied.

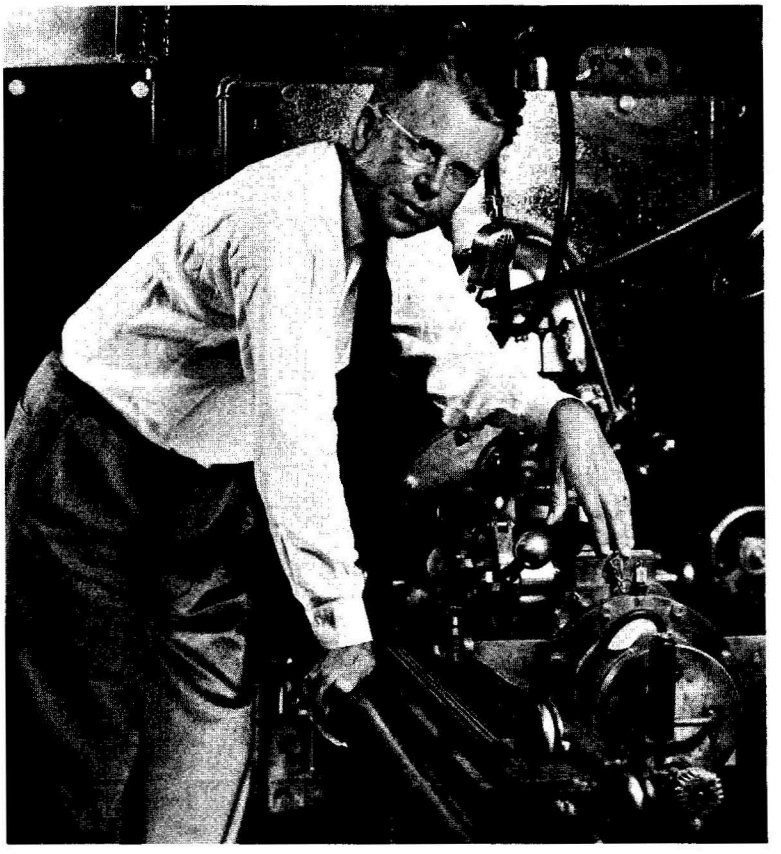
The research supported by grants is independently conceived and proposed by faculty members at large and small institutions in the United States and abroad, and is directed primarily toward developing new scientific knowledge. Any rights to the results—including possible patents—are specifically disclaimed by Research Corporation. The goal is to make imaginative, flexible use of funds in vital areas of science that appear to offer great potential.

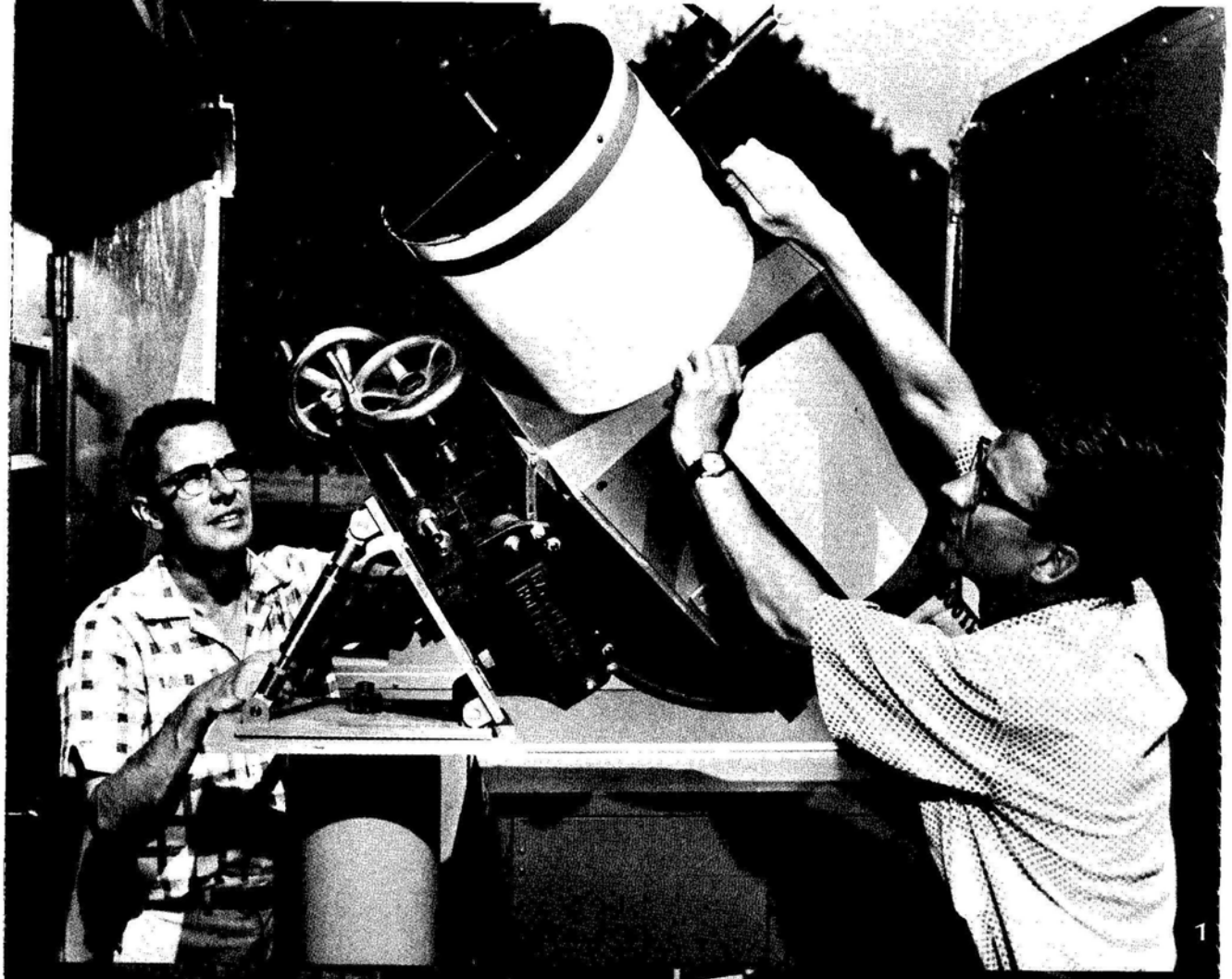
Close liaison is also maintained by patents staff members in their visits to colleges, universities and scientific institutions. They may advise on administering an institutional patent policy, report on the progress of inventions under development, or obtain more details from a faculty inventor in order to assist counsel in filing the strongest possible patent application. It is possible for both patents and grants representatives to be on the same campus on a given day without ever crossing paths, for their missions are entirely separate.

These ties are maintained in part by grants staff members

Today, Research Corporation stands as a vigorous, growing foundation for the advancement of science, faithful to the tasks set for it by its young founder 60 years ago. "If Research Corporation operates on the basis of 'spend as you go' it will be running on its own momentum and *have* to keep alive," he once said. Yet another Cottrell credo repeated in a conversation shortly before his death in 1948, and still reflected in the foundation's grants policies, was "Bet on the youngsters. They are long shots, but many will pay off."

The first of the atom smashers was not as imposing as this later version. Ernest O. Lawrence, shown here, constructed it with loops of magnet wire suspended from two clothes trees. He dreamed of a practical model, but was without funds, a youngster in an exotic new field. In a case of scientific serendipity, Cottrell met Lawrence in 1931, and suggested that Research Corporation bet on him. Money was found for a magnet for the first large cyclotron, a device that changed the course of history.





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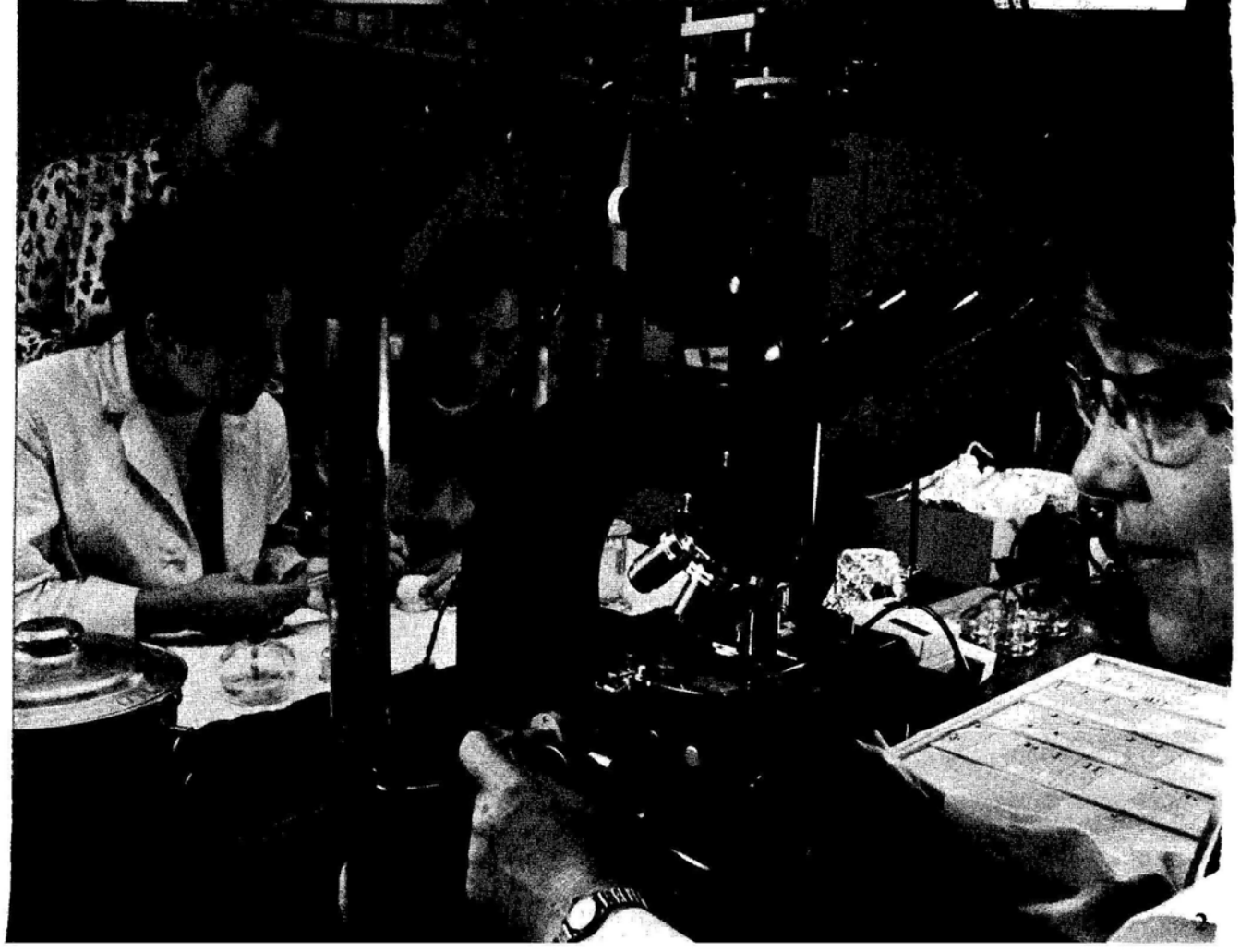

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Student involvement in research enrolls youth and enthusiasm in science at the undergraduate level. (1) A part of a mobile infrared observatory at Southwestern at Memphis, the Newtonian telescope feeds an infrared spectrometer. (2) At Vassar, students and professor cluster around microscope in summer research on cell biology.

new knowledge through research

SCIENTIFIC SIGNIFICANCE, youth, imagination, a willingness to take a risk—all are qualities that have traditionally played a role in Research Corporation grants. In advancing science, foundation funds have provided equipment for laboratories, expanded the horizons of teachers and their students, and supported the work of researchers who have gone on to become outstanding scientists.

An example of the multiplier effect of such grants is one made to the State University of Iowa to help support the research of James A. Van Allen, discoverer of the intense radiation belts surrounding the earth. "I started out with a bare room, a smile and a shoeshine," Van Allen wrote years later. Yet the program he launched with a Research Corporation grant produced 11 Ph.D.'s and 19 Master's degrees from 1952 to 1960.

In Van Allen's words, these graduates had "a considerable influence in diverse ways throughout the national effort in the space sciences."

He had received a grant made under a program originally designed to stimulate the return of scientists to academic laboratories after World War II. Science had taken enormous strides under the impetus of wartime requirements, and the Frederick Gardner Cottrell Program, conceived after VJ day as a $2.5 million, five-year effort, was intended to help provide, in connection with good research proposals, the sophisticated apparatus and assistance sorely needed to rebuild university science.

With the lone exception of the Office of Naval Research, the Cottrell Program was, for nearly a decade, the only nationally available source of funds for research in the physical sciences. It held this position with an annual budget of considerably less than a million dollars. Still, the 200 to 400 Cottrell grants each year made the difference between growth and stagnation for

research of James A. Van Allen, discoverer of the

hundreds of scientist-teachers, and gave them the recognition of outside support when such moral backing was critical.

The five-year postwar program proved so well suited to the real needs of academic science that, with some variations, it has been continued to this day. "I firmly believe that there are many useful and significant things which may be done in an area we may, for the lack of a better name, call 'little science,' " wrote one grantee-investigator, an assistant professor of chemistry. "It is unlikely that any other agency gets more worthwhile research for its money than does Research Corporation."

A case in point was provided by Grote Reber, a pioneer in radio astronomy. In the early 1950s, a grant of $15,000 by Research Corporation made possible Reber's observations of cosmic radio noise and atmospheric phenomena from a mountaintop in Hawaii—to the amazement of those who had estimated that he would need ten times the amount he requested to carry out the project.

"To fabricate the framework for his antenna, haul it 60 miles, and erect it at an altitude of 10,000 feet, with the help of a few men and do it for so little is just beyond comprehension," wrote the Maui school commissioner of Reber's work. The data from this project and others conducted by Reber were equally impressive, and helped establish the new science of radio astronomy.

strengthening science at smaller institutions

The year 1952 saw the organization of the National Science Foundation. Through it and mission-oriented government agencies, much more financial assistance gradually became available for fundamental work in the physical sciences.

With the changed circumstances, Research Corporation began experimenting with new ways to strengthen its contribution to academic science. One result of these trials was a ten-year program started in the late 1950s to upgrade the sciences at liberal arts colleges and smaller universities.

Grants under the liberal arts college program, intended to spur whole science departments or divisions, grew larger than ever before. They ranged from several thousand dollars to one of $325,000 to Denison University for a five-pronged effort in biology, chemistry, geology, mathematics and physics. When

estimated that he would need ten times the amount he

this grants program was phased out in 1968—once again because much larger Federal support (and in this case private as well) had been brought to bear—over $6 million had been distributed to 96 different institutions.

What had been accomplished? A report from the president of a college which received one of these grants for its physics and chemistry departments points out some of the broader results. "The strengthening of teachers and research in these departments," he wrote, "has had a strong influence on other departments of science, mathematics and even into the humanities. The flavor of research has been much more palatable in the college community."

Science in smaller colleges faced a new crisis in the 1970s due to cuts in Federal funding and increasing costs. The present Cottrell College Science Program was designed in response to this challenge. Its grants are to help maintain and

Space sciences pioneer James A. Van Allen traces the Van Allen radiation belts surrounding earth. His research, aided at an early stage by a foundation grant, later attracted far greater support.



improve the quality of science at private undergraduate colleges: institutions lacking tax support and not generally recipients of substantial Federal research funds.

The goal of the college program is to aid those vital institutions which provide undergraduate education for many students entering the sciences, engineering and medicine. At the same time, Research Corporation's support continues for imaginative new investigations proposed by scientists at academic institutions of established research reputation.

the fight against malnutrition

Applied research aimed at overcoming dietary diseases and alleviating the plight of millions suffering from malnutrition is a far cry from basic research in the physical sciences, but it is in keeping with the ideals of Frederick Gardner Cottrell and those who later expanded his endowment.

With the gift of patent rights to vitamin B_1 in 1935, Robert R. Williams, Robert E. Waterman and their colleagues specified that two-thirds of the royalties donated to Research Corporation were to be used for a "Williams-Waterman Fund for the Combat of Dietary Diseases." The remaining one-third was to help support the foundation's existing grants programs.

By 1940, enough royalties had been earned to enter the battle against malnutrition, and grants under the new fund were distributed fairly evenly between basic research and efforts to find practical solutions to dietary deficiencies. As possible answers were found, attention was turned toward applying the knowledge in underdeveloped nations where the need was—and continues to be—greatest.

Direct attacks against infant malnutrition, which kills up to half of the preschool children in some of these countries, are today mounted with the help of the Williams-Waterman Program. In addition, efforts are strongly supported to expand and improve indigenous food supplies and to fortify foods with needed vitamins and minerals.

Over the years, the program has chalked up impressive victories against the ravages of beriberi, pellagra, protein-calorie malnutrition and other dietary diseases. Among the highlights were steps that led to the adoption of flour enrichment standards in this country and the fortification of whole corn meal to combat pellagra in the South. A dramatic

With the gift of patent rights to vitamin B_1 in 1935, Robert R.

(1) Boiling liquid nitrogen vaporizes around the Dewar that cools a precision gamma ray detector in foundation-aided research at Nebraska Wesleyan. Setup of the device, used by students and faculty to analyze radioactive substances, is assisted by Walter R. French, Jr., Physics Department head (right).

(2) Modest grants to assist chemist Neil Bartlett led to the overthrow of a chemical "law." Working at the University of British Columbia, Dr. Bartlett proved that noble gases, long thought inert, would react with fluorine compounds. For his research, which threw new light on chemical bonds, he received 1965 Research Corporation Award.

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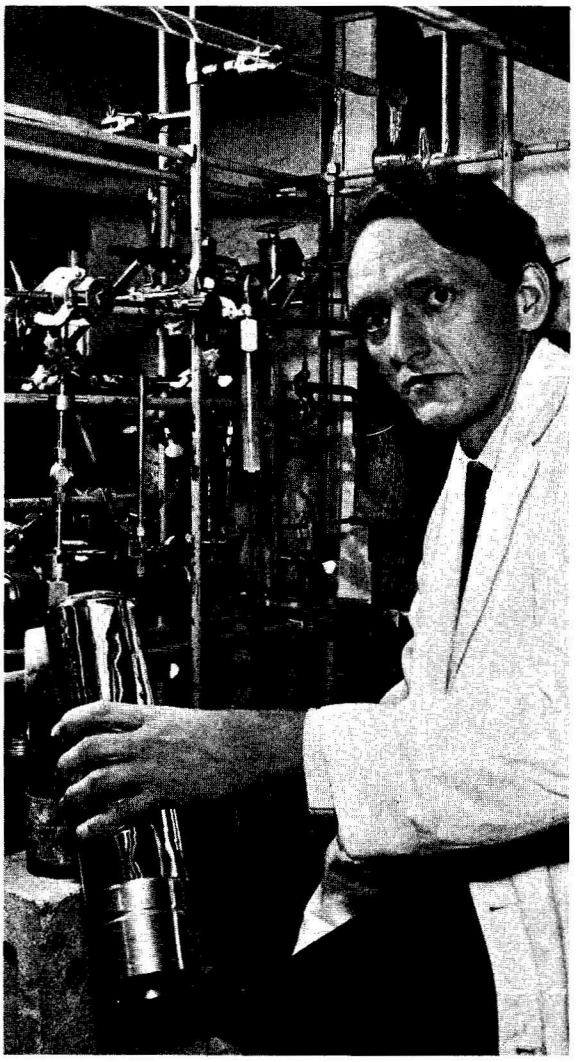


example of work abroad was the experimental enrichment of white rice with vitamin B_1. The treated grain virtually eradicated beriberi in a region of the Philippines where it had been rampant for decades.

Typical of the pragmatic, humanitarian approach of the Williams-Waterman Program is its championing of "Nutritional Rehabilitation Centers" for underdeveloped countries. These modest establishments, also known as "Mothercraft Centers," reduce the toll due to malnutrition by teaching mothers how to keep their children alive and healthy with low-cost, locally available foods.

A handbook for setting up such centers in nations where they can save lives was published in 1970 using material derived from an international conference sponsored by the foundation. Available in both Spanish and English, *A Practical Guide to Combating Malnutrition in the Preschool Child* is now the manual for center operation in more than a dozen countries.

Although not directly connected with practical efforts against malnutrition, there is another international result of the

Practical efforts against infant malnutrition are mounted with the help of Williams-Waterman Grants. Ivan D. Beghin measures thickness of body fat on back of Haitian baby in a test for protein-calorie malnutrition.



Williams-Waterman contribution. Royalties earned in West Germany from the vitamin B_1 patents supported a seven-year natural sciences grants program in that country which was administered by outstanding German scientists. Partial results of the 139 grants that were made from 1954 to 1961 are reported in over 200 scientific publications which fill five volumes in the foundation's library.

Although the patents on vitamin B_1 have long since expired along with royalty payments, resources provided by Research Corporation insure that the Williams-Waterman Program will continue. In 1971, the largest single grant ever awarded by the foundation—over $2 million—was committed to a five-year project to be carried out at the Institute of Nutrition of Central America and Panama, an agency of the Pan American Health Organization. The funds will help improve the food resources of Latin America through research and training in the food sciences and animal nutrition.

other inventions that aid research

Fungal infections afflict a large part of the world's population, yet few clinicians are able to diagnose the disorders and there is little effective therapy. Appropriately, proceeds from the first effective antifungal antibiotic, nystatin, now support mycological research and training of research personnel, with emphasis on basic and adaptive research in medical mycology.

The work is made possible by the Brown-Hazen Program, founded with patent rights donated by inventors Elizabeth Hazen and Rachel Brown. Until its concentration on mycology in 1973, the program had long aided a broad spectrum of research in microbiology, biochemistry and immunology.

A 1958 grant to the California Institute of Technology aided an investigation of mutant genes in phage virus by Max Delbrück, a Nobel Prize winner 11 years later. A 1967 grant to Instituto Politecnico Nacional, Mexico, had the sought-for multiplier effect, launching independent research on enzymes in fungi by Carlos Casas-Campillo, a new faculty member. Within three years, the project had sparked a research group of 12 working in a well-equipped laboratory, and had attracted independent financial support.

Other grants have strengthened whole departments in the life sciences at colleges and small universities, supported

summer research programs, and stimulated much basic work in biochemistry, immunology and microbiology throughout the U. S., Canada and Mexico.

Advanced training in medical mycology and a better understanding of fungal diseases were the targets of the largest Brown-Hazen grants made in the early 1970s to Temple and Columbia Universities. By 1973, the patent on nystatin, in the 16th year of its 17-year life, had contributed over $8 million to such research and to the other grants programs of the foundation.

The patent on a revolutionary method of producing hybrid seed corn has resulted in still another grants activity. This is the Donald F. Jones Fund, conceived by Paul C. Mangelsdorf and the late Donald F. Jones and established in 1970 with royalties from the use of the process.

The first grant of $25,000 helped finance a study of genetic vulnerability to disease in major food crops. It was carried out by the National Academy of Sciences-National Research Council. In addition, graduate and postdoctoral fellowships are awarded for research in the field of cytogenetics of species of agricultural importance.

flexible support for science

How can foundation funds best be applied to stimulating and supporting meaningful research? Grants procedures for all Research Corporation programs are designed to accomplish this by giving each proposal an expert and impartial hearing. The grants staff member most familiar with the applicant and his institution makes a preliminary appraisal. Additional comments on the proposed research are sought from referees—scientists specializing in the areas involved. With all of the data in, an advisory committee—specific for the program involved—applies its expertise and votes to support or deny the proposal.

Distinguished members of the academic community serve on these committees, each representing a discipline of primary concern to his committee and its grants program. Members also represent different types of institutions eligible for grants, as well as different geographical regions. They serve without compensation, donating hundreds of hours each year to help the foundation make a maximum contribution to academic science.

The grants procedures are well adapted to most requests for support. Occasionally, however, a situation develops where an

investigator with a good research problem has an unexpected chance to get the work started—if he can get outside support quickly. A unique Research Corporation granting activity has been devised to take advantage of these opportunities.

These discretionary grants made by the foundation staff have helped the Arctic Institute of North America acquire an airborne radio depth sounder for measuring glacier mass, assisted Universidad Nacional de Mexico in testing a site for an astronomical observatory, and helped initiate a University of Utah cosmic ray project that led to the discovery of a new subatomic particle.

These projects, like the less spectacular but equally important laboratory research aided by discretionary grants, would have been handled by regular procedures had time permitted. In all cases, a fast response was needed—for equipment and supplies, stipends for research assistants or a contribution to unusual expenses—and a check was in the mail in a few days. In short, discretionary grants make possible much

With a significant problem to be solved, sophisticated apparatus becomes a big item in grants made by the foundation. For an investigation of scattering of low-energy electrons by gases, Richard C. Stern (right), Assistant Professor of Chemistry at Columbia, required a vacuum system, laser-excited electron source, X-Y recorder and other instrumentation. A graduate student assists with the research.



Among the outstanding scientists given Research Corporation Awards were 15 who later received Nobel Prizes. Here, Brian D. Josephson of the University of Cambridge receives the 1969 Award for his work with superconductors. Left to right are Lord Adrian, Chancellor of Cambridge; Dr. Josephson; James S. Coles, President of Research Corporation; British Ambassador John Freeman.



Research Corporation Award Winners 1925-1969

John J. Abel, 1925
Ernst Antevs, 1930
Neil Bartlett, 1965
Harold S. Black, 1952
Percy W. Bridgman, 1937
Vannevar Bush, 1938
Melvin Calvin, 1959
Paul J. Cohen, 1963
Francis H. C. Crick, 1961
James W. Cronin, 1967
Bergen Davis, 1929
Andrew Ellicott Douglass, 1930
Lee DuBridge, 1947
Henry Eyring, 1948
William M. Fairbank, 1964
Val L. Fitch, 1967
Murray Gell-Mann, 1968
Samuel A. Goudsmit, 1953
Werner Heisenberg, 1929
Heisuke Hironaka, 1963
Brian D. Josephson, 1969
Edward C. Kendall, 1949
Willis E. Lamb, Jr., 1954
Ernest O. Lawrence, 1937
Willard F. Libby, 1951
Bernd T. Matthias, 1962
Edwin M. McMillan, 1950
Rudolf Ludwig Mössbauer, 1960
Marshall W. Nirenberg, 1966
Bruno Rossi, 1948
Claude E. Shannon, 1956
Hugh S. Taylor, 1938
Charles H. Townes, 1957
Merle Tuve, 1947
George E. Uhlenbeck, 1953
James D. Watson, 1961
Robert B. Woodward, 1955
Chien-Shiung Wu, 1958

exciting, challenging research that would otherwise not be performed.

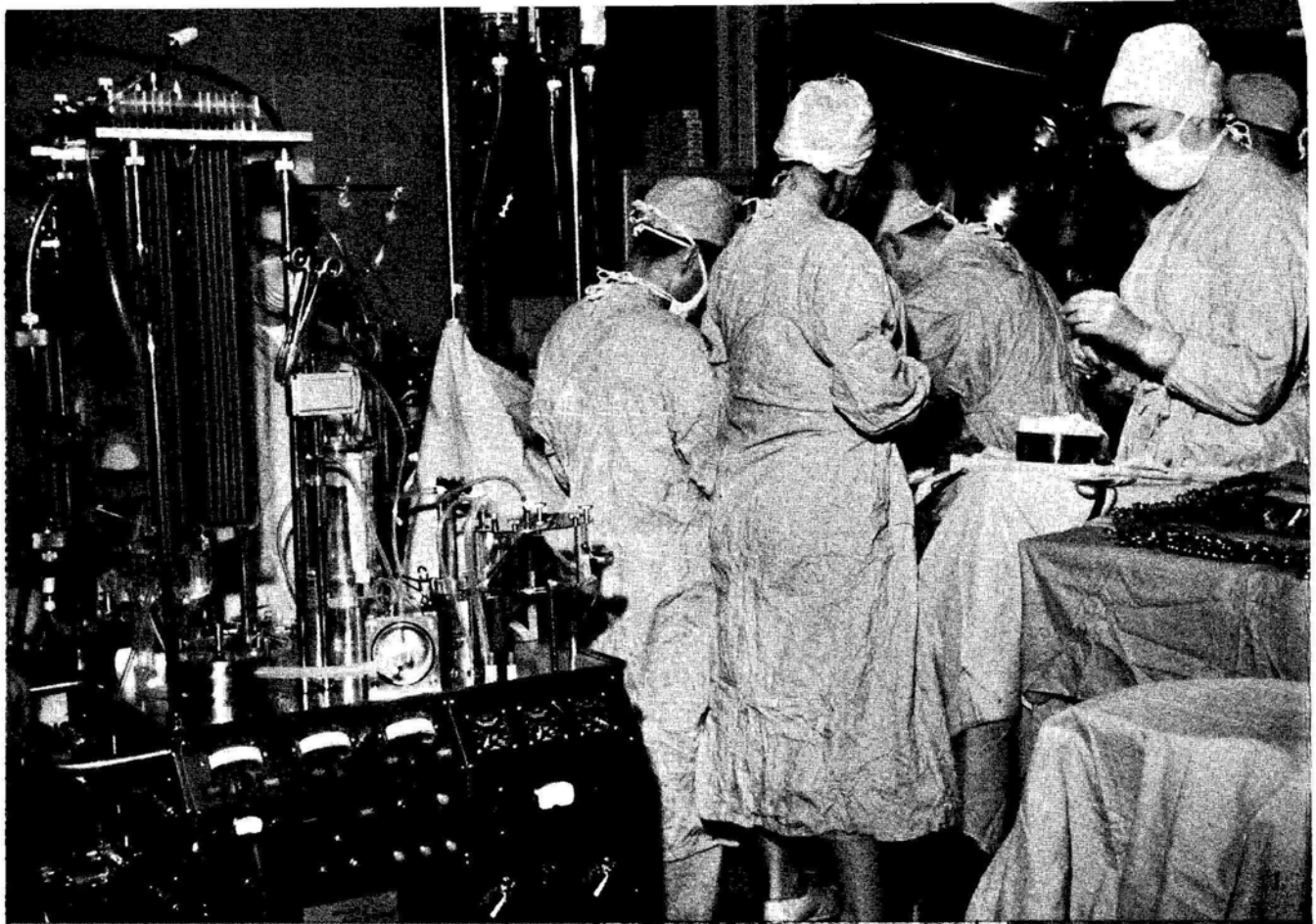
Public recognition for scientific accomplishment provides another means for supporting and encouraging research. Rewarding important work in science which had not been accorded other significant honors was the goal of the Research Corporation Awards which were given at irregular intervals from 1925 to 1969 to "men of science who have made outstanding contributions to human knowledge." Exceptional selections were made by independent juries of prominent scientists, for 15 of the 38 researchers chosen for the Award later received Nobel Prizes.

Following suspension of the Research Corporation Award in 1970, a new award was established by the foundation in the National Academy of Sciences to honor the founder of Research Corporation and his work as a conservationist. Presented annually by the Academy, The Frederick Gardner Cottrell Award for Environmental Quality recognizes "outstanding contributions based in science or technology to improve the quality of the environment or in the control of its pollution by man."

Since its birth in 1912, Research Corporation has awarded a total of $46 million in grants (currently at the rate of about $4 million annually) to more than 4000 scientists at hundreds of institutions in this country and abroad. While dollars invested—like equipment purchased, science graduates produced, investigators supported or scientific papers published—may be measures of accomplishment, there have been other important results.

The value of the first outside recognition for a young researcher, the upgrading of a whole science department, the salvage of a worthwhile piece of research that otherwise might not be done, all are effects that can be described but not measured.

The fostering of a climate favorable to research and teaching is another intangible result of productive grants. "All levels of students, undergraduate through postdoctoral, have been drawn into the project's sphere of influence," reported one recent grantee. "The support has contributed not only to the production of basic chemical knowledge but simultaneously . . . to education in creativity."





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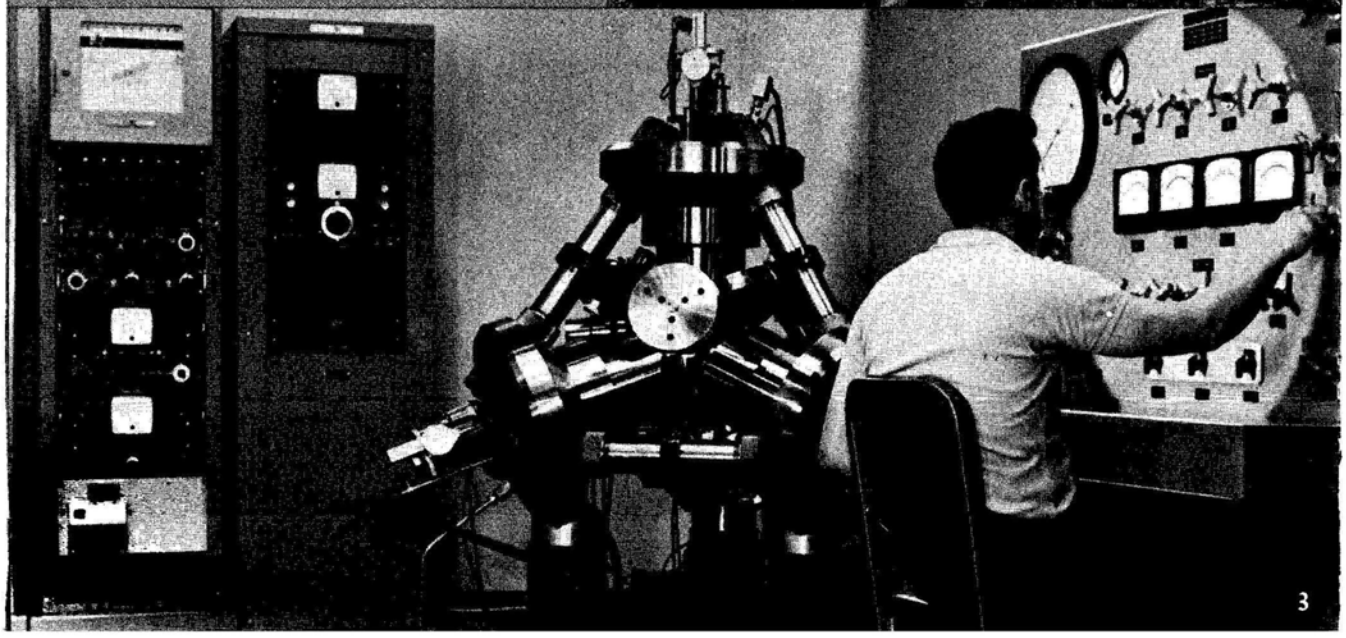


3

(1) A surgical team repairs a damaged heart using Mayo-Gibbon heart-lung machine, an invention which helped make open heart surgery possible. (2) A Cornell scientist checks insect monitoring trap baited with a synthesized sex attractant being developed to replace persistent pesticides. (3) Tetrahedral anvil press invented at Brigham Young to explore crystalline structure exerts up to 2,000,000 psi at 1000° C, can produce artificial diamonds. Foundation invention services speed the use of these and many more innovations.

invention and the public interest

THE INVENTION DISCLOSURES undergoing evaluation by the patent programs group of Research Corporation during any given period may range from new laboratory instruments, computer programming techniques or a better method for producing steel, to such items as food flavorings, a new antibiotic or an incubator for premature infants. The list is endless—more than 10,000 new inventions were evaluated up to 1973—and highly diversified.

In its unique form of scientific midwifery, the foundation has helped make available such inventions of elemental significance as the cyclotron, Van de Graaff generator, the ultracentrifuge and the laser. The list of pharmaceuticals is equally impressive and includes merthiolate, pantothenic acid, cortisone, reserpine, nystatin and vitamins A, B_1 and B_{12}.

More recent are such developments as computer hardware and software, food harvesting machinery, an aircraft pilot trainer, a heart-lung machine and an artificial kidney. In chemical and pharmaceutical fields are sugar ester detergents, plant growth regulants, animal feed additives, a process for making cheese, a burn ointment, artificial musks and a chemical system for controlled release of synthetic hormones.

New industrial processes make up another class of valuable inventions. Current examples include methods for freeze-branding cattle, constructing chairs, strengthening glass for eyeglasses and automobile windshields, and revolutionary techniques for producing hybrid grains.

Research Corporation was established to put to work this flow of useful ideas from university laboratories, and the need is as great today as it was in 1912. In that day industry had yet to discover the value of research. For their part, academic researchers and their institutions had little interest in

commercializing their discoveries and no idea how to proceed. The foundation was to serve as a middleman, remaining responsive to the needs of science and society.

Although many in the academic world shared Cottrell's belief that an obligation existed to make knowledge mined out in the laboratory available to the public, they had little enthusiasm for becoming involved with inventions resulting from faculty research. The objections were several.

Patenting and licensing an invention smacked of selfish motives. It was far removed from theoretical research with the sole aim of advancing science. Why not just make inventions freely available to all manufacturers?

commercial development made possible

Cottrell's reply, in a published article, pointed out that "A certain minimum amount of protection is usually felt necessary by any manufacturing concern before it will invest in the machinery or other equipment . . . to put a new invention on the market. Thus a number of meritorious patents given to the public absolutely freely by their inventors have never come upon the market chiefly because, 'what is everybody's business is nobody's business.' "

In keeping with its chartered purpose of rendering inventions, patent rights and letters patent more available and effective, Research Corporation would not only protect the public interest, but insure the public would actually benefit from new inventions.

Such was the theory, but how could the foundation play a practical role? It was obviously not feasible for Research Corporation to develop—as it had done with the Cottrell invention—a great many diversified devices, compounds, products and processes. On the other hand, it might shepherd new inventions along to the point where others could carry them forward.

First and foremost, evaluations would have to be made to determine if embryonic, scientifically-oriented ideas springing from academic laboratories were novel and useful, and if they could command attention in the marketplace. The foundation would accept assignment of promising discoveries, find patent attorneys to file and follow up patent applications, and encourage commercial firms to take on the inventions.

made possible

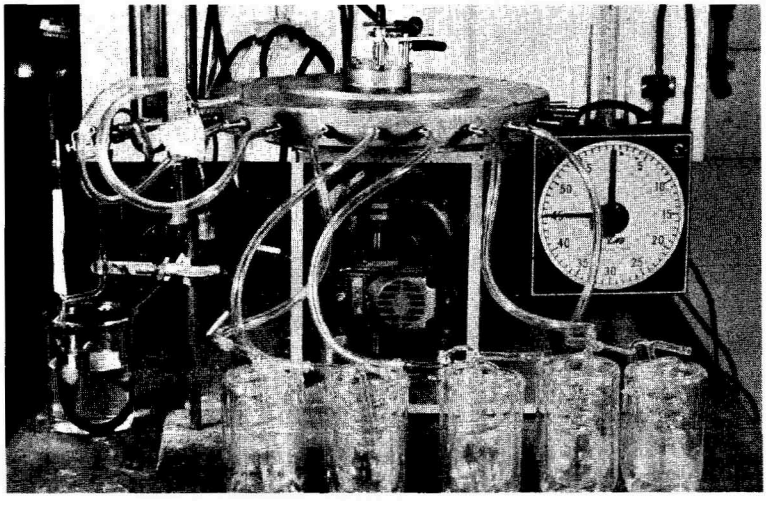
As requests for invention assistance became more frequent, Research Corporation's role was formalized by means of agreements between the foundation and educational institutions. The first such agreement was made with Massachusetts Institute of Technology with the help and encouragement of Cottrell and men like Karl T. Compton and Vannevar Bush. Signed in 1935, it set the pattern for the future.

A system was set up for contributing essential services, and it is still followed today. Following a favorable evaluation, inventions are assigned to Research Corporation for patenting and licensing. All expenses, except those in certain types of litigation, are borne by the foundation whether or not the invention is successful. If it is successful, a percentage of the gross royalties—typically about 15 percent—is allocated to the inventor by the foundation or by his institution.

Remaining royalties are divided by the foundation and the institution, both constituting contributions to academic and research purposes.

The variety of the over 250 institutions having invention administration agreements with Research Corporation rivals that of the discoveries evaluated by the foundation. Included are

Inventions may be judged on their scientific importance even though the demand for them is limited. This research instrument, a chromatograph invented at Tufts and patented by the foundation, is expected to find laboratory use for analyzing liquids and gases by continuously separating them into component parts.



major universities such as Princeton, Harvard, Yale, Stanford and the University of Chicago as well as many smaller colleges and universities; research organizations such as Rand Corporation, Mayo Clinic and the Franklin Institute; charitable groups including the American National Red Cross and the American Heart Association; foreign organizations from Britain's government-sponsored National Research and Development Corporation to the Japan Engineering Development Company.

foretelling the future

The evaluation of inventions might be termed a feat of technological legerdemain, for it requires an ability to foresee the unknown applications for a new chemical compound, a mechanical device or a laboratory instrument, and to estimate the perils to be encountered in its development and testing.

A new antibiotic appears only mildly interesting—until it is discovered to have valuable properties previously unsuspected. A method for strengthening glass is simply an addition to a well-developed technology—until the new material proves ideal for shatterproof eyeglasses. On the other side of the coin, an industrial molding machine appears very practical—until an unsuspected mechanical snag develops. A superior processed food offers bright hopes—but dies for lack of consumer acceptance.

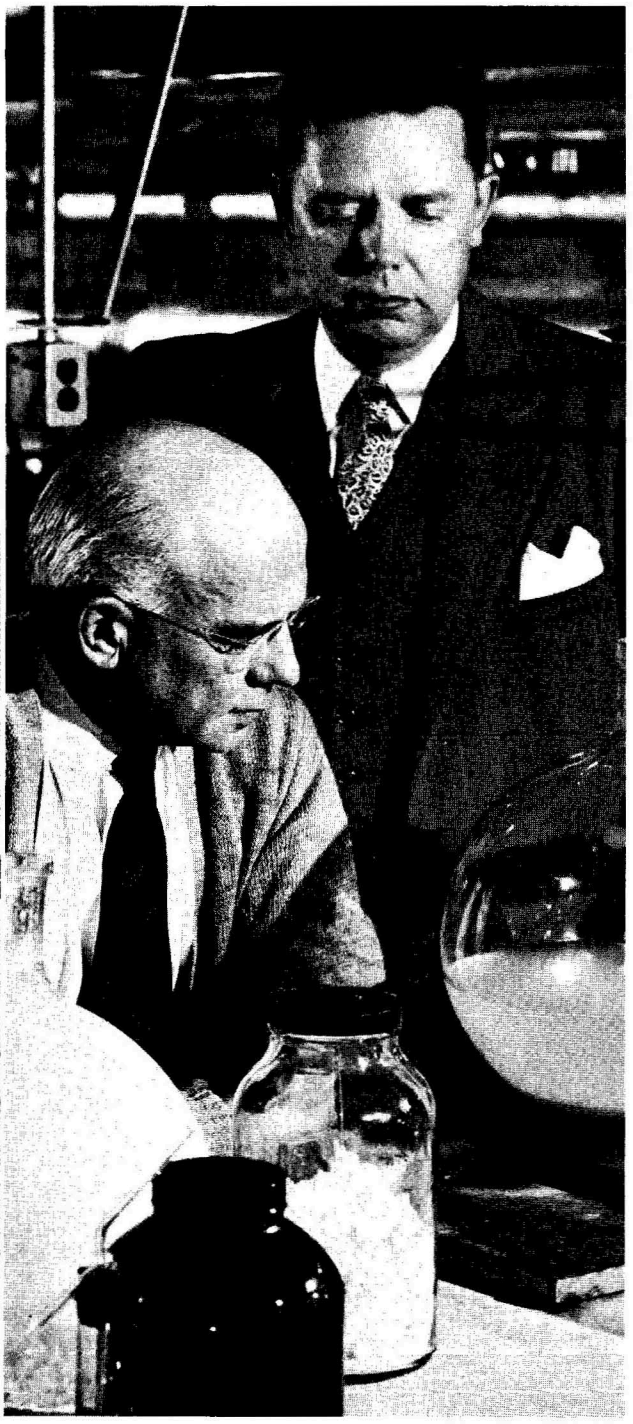
Present always is the possibility that an obscure invention may have the impact of the telephone or the transistor; polio vaccine or penicillin.

Useful inventions are hidden within the disclosures, theses or manuscripts submitted to the foundation, but it takes careful consideration and winnowing to discover them. Technical, marketing, financial and legal consultants participate in this interdisciplinary effort to gauge the impact of new technology.

Does the invention show originality and patentable novelty? Does it represent a new, better, or more economical device or process? During 1972, 452 invention disclosures evaluated by Research Corporation netted 38 that met these tests. Assuming the invention is useful, is it worth patenting? Would it have applications abroad, and in what countries? In 1972, 37 U. S. and 26 foreign patents were issued on projects accepted in

discovered to have valuable properties previously unsuspected.

1



(1) Cortisone—useful against arthritis and other diseases—was quickly made available to the public through foundation licensing efforts. Inventor Edward C. Kendall (seated) and clinician Philip S. Hench shared the Nobel Prize for work on the drug.

(2) A genetic breakthrough led inventors and Research Corporation donors Donald F. Jones and Paul C. Mangelsdorf to a new method of producing hybrid seed corn. In this 1950 photo, Dr. Jones examines male sterile corn tassels.

2



prior years (up to three years elapse between patent application and issuance).

Finally, how and to whom should the invention be licensed for manufacture? Over the past decade, an average of 30 royalty-bearing licenses have been negotiated each year with industrial companies on previously issued patents.

Of the invention disclosures evaluated by Research Corporation, some 10 percent have enough promise to warrant further action and survive to the point of patenting.

Chemically strengthened glass, which can be bent in an arc and is one-third as thick and heavy as other glass of equal strength, may prove ideal for auto windshields, eyeglasses and other applications. Proceeds from licensing this development are benefiting academic programs at the University of Utah where much of the original research was conducted.



Of these, only about 10 percent will be licensed and successfully marketed.

Although they are often not recognized at the outset, these final few inventions, the successful long shots, justify the existence of the foundation's patent programs and make it an exciting endeavor. In 1935, for example, inventor Robert E. Waterman of the Williams-Waterman team was so skeptical of there being royalties in excess of $100,000 from vitamin B_1 that he called it a mythical "box-car number."

By the time the patent had run its 17-year course, almost 100 times that amount had been earned.

from laboratory to marketplace

Licensing an invention for development and manufacture brings a host of new problems that must be solved before the public can benefit. Does the firm—a potential licensee for an invention—have the scientific and technical staff, the financial resources and the other capabilities needed to develop and market the product?

A new drug needing extensive clinical testing and an investment of millions of dollars might be licensed exclusively for a limited time to one large company so that it can recoup development costs. A food product or process needing little further development, on the other hand, might be made immediately available to dozens of smaller producers.

Competing or parallel inventions raise other complex problems. Inventors, institutions and industrial firms in the U. S. and abroad often conduct closely related research and may even produce the same inventions. Clearing the way for public use of the new technology in such cases requires expert legal counsel, skilled diplomacy and lengthy negotiations.

Successful in isolating cortisone, inventor Edward C. Kendall had produced a substance of enormous importance in treating rheumatoid arthritis and other diseases. By 1949, it was obvious that the drug would contribute greatly to the public welfare if freely available, yet patents issued to firms in the Netherlands, Switzerland and the U. S. covered many phases of the 37-step process necessary to produce cortisone in quantity.

As assignee of the Kendall patents, Research Corporation brought the other patent owners together early in 1951. An agreement was worked out whereby a single license would

give pharmaceutical manufacturers the right to use all of the patents. Within two years—an incredibly short period for a development of this kind—cortisone had been made universally available.

the protection of patents

Other inventions require guarantees that the manufacturer will, indeed, expeditiously and effectively develop them in the public interest. Where an invention is immediately useful and available, on the other hand, protection against patent infringement is required.

A unique agricultural invention, a simple, inexpensive method of producing hybrid seed corn, provides an interesting example. Years ago, geneticist Donald F. Jones succeeded in

Cryogenics for cowboys? A new invention combines the two in a painless freeze-branding process. The brand, chilled to −310° F in liquid nitrogen, causes animal hair to grow in white without damaging the leather hide. Inventor R. Keith Farrell of Washington State University examines sample brands.



transforming such seed from a scientific curiosity to a commercial reality, bringing about a virtual revolution in U. S. agriculture.

Then Jones, working with Paul C. Mangelsdorf, made a remarkable genetic refinement that partially eliminated the need to hand detassel the corn grown for seed—a big saving in labor. A further improvement by Jones solved the problem and superseded the earlier invention: hybrid seed corn could now be easily and cheaply produced completely without hand detasseling.

In assigning the inventions to Research Corporation, Jones and Mangelsdorf specified that the major part of any royalties from the process were to go to the Connecticut Agricultural Experiment Station and Harvard University. A third share was allotted to the foundation for research in biology and to help support its other grants programs.

Worthy as these objectives were, the Jones patent was the first in the field of plant genetics, and commercial seed corn growers were reluctant to pay royalties under it. By 1963, some 13 years after a patent application was filed, the Jones process was in widespread use—in infringement of the patent.

After all attempts at licensing had failed, Research Corporation acted to protect the patent, bringing proceedings against major seed corn producers. Seven years later the courts upheld the patent's validity. Royalty payments eventually contributed well over $1 million to the educational and scientific institutions specified by the inventors.

A broader principle was involved, however. In protecting the patent on hybrid seed corn, the foundation helped strengthen the basis on which the entire U. S. patent system rests—the guarantee provided by the Constitution that inventors may for limited times enjoy exclusive rights to their discoveries.

vitamin B_1: a case history

The vital role of the patent system in protecting the public interest was nowhere so apparent as in the synthesis of vitamin B_1 by Williams, Waterman and their colleagues. Despite opposition from well-meaning scientists, the inventors persisted in their efforts to obtain a patent on the process to insure that it would not be used for selfish interests.

Their fears were well-founded, for a foreign pharmaceutical

Worthy as these objectives were, the Jones patent was the

concern had also filed patent applications—later shown to be based on Williams' publications. To whom should the patent be granted? Research Corporation's prosecution of the resulting interference suit in the U. S. Patent Office brought a 1942 decision for the U. S. inventors. A possible world monopoly on vitamin B_1 had been forestalled.

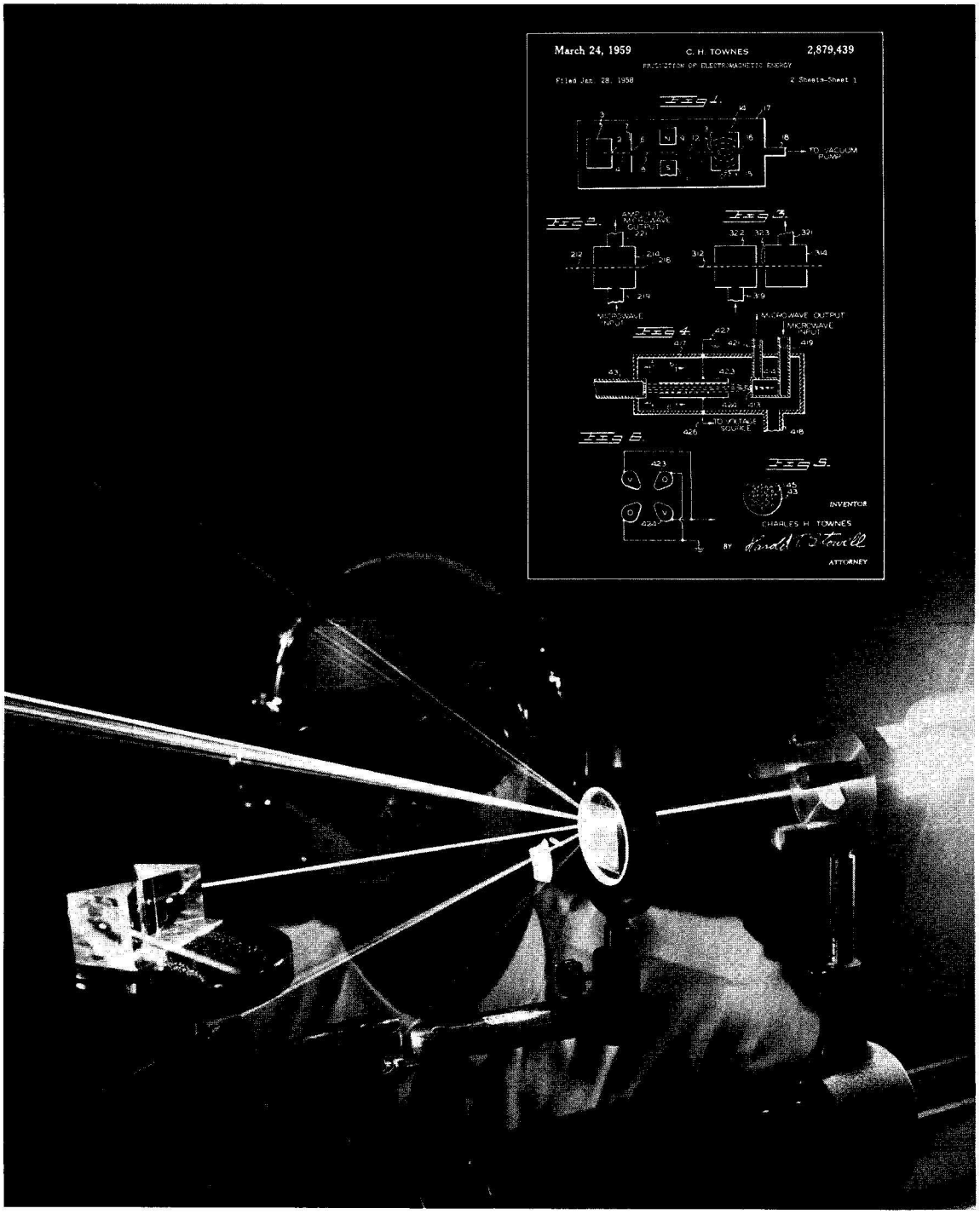
"As long as our patent laws exist there is an obligation on every scientific worker to protect his inventions by patents if he can write a truthful and valid application," said Williams years later. "Protection of the public by mere publication is an unrealistic dream.

". . . Our belief is that the patent system does promote scientific advance and technological invention by providing a stimulus to invent and especially an incentive to disclose discoveries to the public. Without such a patent law secret processes would be in frequent use and public knowledge of technology would depend on spying . . ."

Patenting and licensing in the public interest provided a powerful incentive to make B_1 widely and cheaply available. From a figure of $7.98 a gram in 1936, the price dropped rapidly, reaching its current low of six cents a gram in 1956. At the same time, the invention eventually produced more than $10 million for research in the natural sciences and applied nutrition.

In its handling of vitamin B_1, Research Corporation again demonstrated the validity of Frederick Gardner Cottrell's concept of scientific philanthropy: A foundation to make available inventions of importance to the public; a foundation to apply the proceeds to science for the future benefit of mankind.

The inspiration for the maser, a device that would produce electromagnetic energy by controlled molecular or atomic activity, came to Charles H. Townes in 1951. From his original 1959 patent (inset) and further research flowed the laser which was first demonstrated by H. Maiman in 1960. Today—with lasers finding a wide role in medicine, industrial processes, communications, computers and holography—the Townes patent is administered in the public interest by Research Corporation.



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